ABSTRACTS

of the scientific works for participation in the contest for the academic position of "professor" (Annotations of the materials under Art. 76 (1) of PRASPU for participation in the contest, including self-assessment of contributions) of Assoc. Prof. Atanaska Tencheva Georgieva, PhD Department of Mathematical Analysis FMI of PU "Paisii Hilendarski"

Twenty-three (23) scientific publications and two (2) textbooks are presented for participation in this contest (see List of scientific papers for participation in the contest).

I. Scientific publications

B4.1. **Georgieva A.**, Alidema A., *Convergence of Homotopy Perturbation Method for Solving of Two-Dimensional Fuzzy Volterra Functional Integral Equations*, Advanced Computing in Industrial Mathematics, Studies in Computational Intelligence, (2019), Vol.793, pp. 129-145, Electronic ISSN: 1860-9503, Print ISSN: 1860-949X, https://doi.org/10.1007/978-3-319-97277-0_12, SJR=0.215, Web of Science.

In this paper, Homotopy Perturbation Method (HPM) is applied to solve two-dimensional fuzzy Volterra functional integral equation (2D-FVFIE). We use parametric form of fuzzy functions and convert a 2D-FVFIE to a system of Volterra functional integral equations with three variables in crisp case. We use the HPM to find the approximate solution of the converted system, which is the approximate solution for 2D-FVFIE. Also, the existence and uniqueness of the solution and convergence of the proposed methods are proved. The main tool in this discussion is fixed point theorem. The error estimate in this method is also given. Finally, we give some examples to demonstrate the accuracy of the method. The solved problems reveal that the proposed method is effective and simple, and in some cases, it gives the exact solution.

B4.2. Naydenova I., **Georgieva A.,** *Approximate solution of nonlinear mixed Volterra-Fredholm fuzzy integral equations using the Adomian method*, AIP Conference Proceedings, (2019), Vol. 2172, 060005, ISBN: 978-0-7354-1919-3, https://doi.org/10.1063/1.5133533, SJR=0.19, Web of Science.

An analytical method for solving two-dimensional nonlinear Volterra-Fradholm fuzzy integral equation of the second kind will is introduced. We convert a nonlinear Volterra-Fredholm fuzzy integral equation to a nonlinear system of Volterra-Fredholm integral equation in crisp case. We use Adomian Decomposition Method to find the approximate solution of this system and hence obtain an approximation for fuzzy solution of the nonlinear Volterra-Fredholm fuzzy integral equation. Also, the existence and uniqueness of the solution and convergence of the proposed method are proved. Numerical example is included to demonstrate the validity and applicability of the proposed technique.

B4.3. Georgieva A., Pavlova A., Trenkova L., *Homotopy Analysis Method to Solve Volterra-Fredholm Fuzzy Integral Equations*, Studies in Computational Intelligence, (2021), Vol. 961, pp. 110-122, Print ISBN: 978-3-030-71615-8 Online ISBN: 978-3-030-71616-5, DOI: 10.1007/978-3-030-71616-5_12, SJR=0.237, SCOPUS.

In this paper, we consider the two-dimensional nonlinear Volterra-Fredholm fuzzy integral equation. Homotopy Analysis Method is used to determine the approximate solution of the investigated equation. We convert fuzzy Volterra-Fredholm integral equation to a system of Volterra-Fredholm integral equations in a crisp case. Hence, we obtain approximate solutions of this system and consequently obtain an approximation for the fuzzy solution of the fuzzy Volterra-Fredholm integral equation. We prove the convergence of the proposed method and find an error estimate between the exact and the approximate solution. A numerical example is given to demonstrate the validity and applicability of the proposed technique.

B4.4. Georgieva A., Naydenova I., *Adomian's Decomposition Method and Homotopy Perturbation Method in Solving Two-Dimensional Volterra-Fredholm Fuzzy Integral Equations*, AIP Conference Proceedings, (2021), Vol. 2321, 030009, ISBN: 978-0-7354-4065-4, https://doi.org/10.1063/5.0040135, SJR=0.189 ,Web of Science.

In this paper, we conduct a comparative study between the Homotopy Perturbation Method (HPM) and Adomian Decomposition Method (ADM) for analytic treatment of nonlinear two-dimensional Volterra-Fredholm fuzzy integral equations and we show that the HPM with a specific convex homotopy is equivalent to the ADM for these type of equations.

B4.5. Georgieva A., Naydenova I., *Approximate solution of nonlinear Volterra-Fredholm fuzzy integral equations*, AIP Conference Proceedings , (2022), Vol. 2505, 070002, ISBN: 978-0-7354-4396-9, https://doi.org/10.1063/5.0100646, SJR=0.19, SCOPUS.

In this paper, we consider the two-dimensional nonlinear Volterra-Fredholm fuzzy integral equation (2D-NVFFIE). The Homotopy Analysis Method is used for determining the approximated solution of the investigated equation. We convert 2D-NVFFIE to a system of nonlinear Volterra-Fredholm integral equation in crisp case. Hence, we obtain an approximate solutions of this system and consequently obtain an approximation for the fuzzy solution of the Volterra-Fredholm fuzzy integral equation. We proof the convergence of the proposed method and error estimation between the exact and the approximate solution. A numerical example is given to demonstrate the validity and applicability of the proposed technique.

Г7.1. Georgieva A., Kostadinov S., Stamov G., Alzabut, J. O., *On L-p(k)-equivalence of impulsive differential equations and its applications to partial impulsive differential equations*, Advances in Difference Equations, (2012), Article Number 144, ISSN: 16871839, https://doi.org/10.1186/1687-1847-2012-144, SJR=0.684, IF=0.76, Q2, Web of Science.

By means of the Schauder-Tychonoff principle, Lp(k)-equivalence are established between linear and nonlinear perturbed impulsive differential equations with an unbounded linear part in an arbitrary Banach space. The feasibility of our theoretical results is illustrated by an example involving partial impulsive differential equations of the parabolic type.

Г7.2. Georgieva A., Kiskinov H., Kostadinov S., Zahariev A., *Psi-exponential dichotomy for linear differential equations in a Banach space*, Electronic Journal of Differential Equations, (2013), Vol. 2013, No. 153, pp. 1–13, ISSN:1072-6691, SJR= 0.543, IF=0.419, Q3, Web of Science.

In this article we extend the concept ψ-exponential and ψ-ordinary dichotomies for homogeneous linear differential equations in a Banach space. With these two concepts we prove the existence of ψ-bounded solutions of the appropriate inhomogeneous equation. A roughness of the ψ-dichotomy is also considered.

Г7.3. Bohner M. J., **Georgieva A.**, Hristova S., *Nonlinear Differential Equations with "Maxima": Parametric Stability in Terms of two Measures*, Applied Mathematics & Information Sciences, An International Journal, (2013), Vol. 7, No. 1, pp. 41-48, ISSN: 1935-0090 (print) ISSN: 2325-0399 (online), DOI: 10.12785/amis/070105, SJR=0.406, IF=1,232, Q1, Web of Science.

This paper investigates parametric stability for nonlinear differential equations with "maxima". Several sufficient conditions for parametric stability as well as uniform parametric stability are obtained based on the Razumikhin method. Two different types of Lyapunov functions have been applied. A comparison with scalar ordinary differential equations is offered.

Г7.4. Zahariev A., Zlatev S., **Georgieva A.**, *Non-oscillatory solutions of odd-order linear functional differential system of neutral type with distributed delay*, C. R. Acad. Bulg. Sci., (2013), Vol. 66, No. 6, pp. 793-800, ISSN: 1310-1331, IF=0.198, Q4, Web of Science.

In the present paper we establish explicit and easy computable sufficient conditions for existing of several types of non-oscillatory solutions of linear delayed system of neutral type with distributed delay. The results are proved by numerical range technique, and generally they are applicable in the case of non-monotone measures too.

Г7.5. Zahariev A., **Georgieva A.,** Trenkova L., *On Voltera- type Integral Equations on noncompact metric space,* Journal of Inequalities and Applications, (2014),Vol. l, Article Number 260, ISSN:1029-242X, https://doi.org/10.1186/1029-242X-2014-260, SJR=0.395, IF=0.773, Q2, Web of Science.

In the present work, we consider one of the possible generalizations of linear and nonlinear Volterra integral equations of the second kind in the case when the independent variable belongs to an arbitrary noncompact metric space. Sufficient conditions are obtained for the existence of solutions of Volterra-type integral equations in the nonhomogeneous case. Some applications of the obtained results to the integral inequalities are given.

Г7.6. Georgieva A., Kiskinov H., Kostadinov S., Zahariev A., *Existence of solutions of nonlinear differential equations with psi-exponential or psi-ordinary dichotomous linear part in a Banach space*, Electronic Journal of Qualitative Theory of Differential Equations, (2014), No. 2, pp. 1–10, ISSN: HU ISSN: 1417-3875, https://doi.org/10.14232/ejqtde.2014.1.2, SJR=0.557, IF=0.817, Q2, Web of Science.

In this article we consider nonlinear differential equations with ψ-exponential and ψ-ordinary dichotomous linear part in a Banach space. By the help of the fixed point principle of Banach sufficient conditions are found for the existence of ψ-bounded solutions of these equations on R and R_+.

Г7.7. Georgieva A., Trenkova L., Cholakov S., *On Volterra type integral equations in Hausdorff spaces*, International Journal of Differential Equations and Applications, (2015), Vol. 14, No. 1, pp. 53-64, ISSN: 1311-2872, doi: http://dx.doi.org/10.12732/ijdea.v14i1.2034, Zbl: 1331.47080.

In this article we consider a generalization of the linear and nonlinear Volterra integral equations of first and second kind in the case when the independent variable belongs to arbitrary first-countable Hausdorff space. Sufficient conditions for the uniqueness of the solutions of the Volterra type integral equations of first kind are obtained. As an application of this result the existence of solution of nonlinear Volterra type integral equations of second kind is proved.

Г7.8. Georgieva A., Trenkova L., Atanasova P., *Existence of Continuous Solutions of a Perturbed Linear Volterra Integral Equation*, God. Sofia. Univ., Fak. Mat. Inform., (2016), Vol. 103, pp. 79-88, ISSN: 0205-0808 , Zbl 7360320.

In this paper we study the existence of continuous solutions on a compact interval of perturbed linear Volterra integral equations. The existence of such a solution is based on the well-known Leray–Schauder principle for a fixed point in Banach space. A special interest is devoted to the study of the uniqueness of continuous solution. Our numerical approach is based on a fixed point method and we apply quadrature rules to approximate the solution for the perturbed linear Volterra integral equations. The convergence of the numerical scheme is proved. Some numerical examples are given to show the applicability and accuracy of the numerical method and to validate the theoretical results.

Г7.9. Enkov S., **Georgieva A.,** Nikolla R., *Numerical solution of nonlinear Hammerstein fuzzy functional integral equations,* AIP Conference Proceedings, (2016), Vol. 1789, 030006, ISBN: 978-0-7354-1453-2, https://doi.org/10.1063/1.4968452, SJR=0.165 **,** Web of Science.

In this work we investigate nonlinear Hammerstein fuzzy functional integral equation. Our aim is to provide an efficient iterative method of successive approximations by optimal quadrature formula for classes of fuzzy number-valued functions of Lipschitz type to approximate the solution. We prove the convergence of the method by Banach's fixed point theorem and investigate the numerical stability of the presented method with respect to the choice of the first iteration. Finally, illustrative numerical experiment demonstrate the accuracy and the convergence of the proposed method.

Г7.10. Enkov S., **Georgieva A.,** *Numerical solution of two-dimensional nonlinear Hammerstein fuzzy functional integral equations based on fuzzy Haar wavelets*, AIP Conference Proceedings, (2017), Vol. 1910, 050004, ISBN: 978-0-7354-1602-4, https://doi.org/10.1063/1.5013986, SJR=0.165, Web of Science.

In this paper, we propose an efficient iterative method to solve two-dimensional nonlinear Hammerstein fuzzy functional integral equations based on fuzzy Haar wavelets. We prove the convergence of the method by Banach's fixed point theorem and investigate the numerical stability of the presented method with respect to the choice of the first iteration. Finally, some numerical experiment confirm the theoretical results and illustrate the accuracy of the proposed method.

Г7.11. Georgieva A., Naydenova I., *Numerical solution of nonlinear Urisohn-Volterra fuzzy functional integral equations*, AIP Conference Proceedings, (2017), Vol. 1910, 050010, ISBN: 978-0-7354-1602-4, https://doi.org/10.1063/1.5013992, SJR=0.165, Web of Science.

In the present paper, we propose an efficient iterative numerical method of successive approximations to approximate solution of nonlinear Urisohn-Volterra fuzzy functional integral equations by fuzzy trapezoidal quadrature formula for classes of fuzzy-number-valued functions of Lipschitz type. We prove the convergence of the method and investigate the numerical stability of the present method with respect to the choice of the first iteration. The convergence of the method is tested through a numerical experiment, that confirms the obtained theoretical results.

Г7.12. Atanasova P., **Georgieva A.**, Konstantinov M., *Dichotomous solutions of linear impulsive differential equations*, Mathematical Methods in the Applied Sciences, (2018), Vol. 41 (5), pp. 1753-1760, ISSN: 10991476, https://doi.org/10.1002/mma.4701, SJR=0.666, IF=2.321, Q2, Web of Science.

The notion of Lp(h, k)–solutions of linear impulsive differential equations in Banach spaces is introduced. Sufficient conditions for existence of such solutions are derived. Possible applications to linear control systems with impulses are considered. An illustrative example is given.

Г7.13. Georgieva A., Pavlova A., Naydenova I., *Error Estimate in the Iterative Numerical Method for Two-Dimensional Nonlinear Hammerstein-Fredholm Fuzzy Functional Integral Equations*, Studies in Computational Intelligence, Advanced Computing in industrial Mathematics, (2018), Vol. 728, pp. 41-55, ISSN: 1860-949X, 1860-9503), ISBN: 978-3-319-65529-1, ISBN: 978-3-319-65530-7 (eBook), DOI:10.1007/978-3-319-65530-7_5, SJR=0.183, Web of Science.

In this paper, we prove the convergence of the method of successive approximations used to approximate the solution of two-dimensional nonlinear Hammerstein-Fredholm fuzzy functional integral equations. We present an iterative procedure based on quadrature rectangles to solve such equations. The error estimation of the proposed method is given in terms of uniform and partial modulus of continuity. Finally, an illustrative numerical experiment confirms the theoretical results and demonstrates the accuracy of the method.

Г7.14. Georgieva A., Enkov S., *Iterative numerical method for two-dimensional nonlinear Fredholm fuzzy functional integral equations*, AIP Conference Proceedings, (2018), Vol. 2048, 050010, ISBN: 978-0-7354-1774-8, https://doi.org/10.1063/1.5082109, SJR=0.182, Web of Science.

In this paper we investigate two-dimensional nonlinear Fredholm fuzzy functional integral equation. Our aim is to provide an efficient iterative method of successive approximations by optimal quadrature rule for classes of fuzzy number valued functions of Lipschitz type for two-dimensional case to approximate the solution. We prove the convergence and numerical stability of the presented method with respect to the choice of the first iteration. Finally, some numerical experiment confirm the theoretical results and illustrate the accuracy of the proposed method.

Г7.15. Georgieva A., Pavlova A., Enkov S., *Iterative method for numerical solution of two-dimensional nonlinear Urysohn fuzzy integral equations*, Studies in Computational Intelligence, Advanced Computing in Industrial Mathematics, (2019), Vol. 793 , pp. 147-161, Electronic ISSN:1860-9503, Print ISSN:1860-949X, DOI: 10.1007/978-3-319-97277-0_12, SJR=0.215, Web of Science.

In this paper, we propose an iterative procedure based on the quadrature formula of Simpson to solve two-dimensional nonlinear Urysohn fuzzy integral equations. Moreover, the error estimation of the proposed method in terms of uniform and partial modulus of continuity is given. We extend in the context of using the modulus of continuity, the notion of numerical stability of the solution with respect to the first iteration. Finally, illustrative example is included in order to demonstrate the accuracy and the convergence of the proposed method.

Г7.16. Georgieva A., Melemov H., *Polynomial solutions of differential equations on group SL(2, R)*, Dynamic Systems and Applications, (2019),Vol. 28 (4), pp.847-858, ISSN: 1056-2176, doi: 10.12732/dsa.v28i4.5, SJR=0.208, IF=0.5, Q4, Web of Science.

In this paper, we propose an algorithm for constructing exact polynomial solutions of certain class of linear differential equations on the group SL(2, R). This linear algorithm is carried out by using Lie algebraic technique. The solutions are constructed in the form of finite product of exponentials of nilpotent elements in the Lie algebra sl(2, R).

Г7.17. Georgieva A., Naydenova I., *Numerical method for solving two-dimensional nonlinear Hammerstein-Fredholm fuzzy functional integral equations,* AIP Conference Proceedings, (2021), Vol. 2333, 080004, ISBN: 978-0-7354-4077-7, https://doi.org/10.1063/5.0041601, SJR=0.189, Web of Science.

In this work, we investigate two-dimensional nonlinear Hammerstein-Fredholm fuzzy functional integral equation. We propose an efficient iterative method of successive approximations by using fuzzy variant of the cubature rule of the rectangle for classes of fuzzy number-valued functions of Lipschitz type for two-dimensional case to approximate the solution. We prove the convergence and numerical stability of the presented method with respect to the choice of the first iteration. Finally, some numerical experiment confirm the theoretical results and illustrate the accuracy of the proposed method.

Г7.18. Georgieva A., *Solving Volterra-Fredholm fuzzy integro-differential equations by using homotopy analysis method*, AIP Conference Proceedings, (2022), Vol. 2459, 030011, ISBN: 978-0-7354-4186-6, https://doi.org/10.1063/5.0083627, SJR=0.189, SCOPUS.

The main goal of the paper is to present an approximate method for solving of a nonlinear Volterra-Fredholm fuzzy integro-differential equation (NVFFIDE). It is applied the Homotopy Analysis Method (HAM). The studied equation is converted to a nonlinear system of Volterra-Fredholm integro-differential equations in a crisp case. Approximate solutions of this system are obtained by the help with HAM and hence an approximation for the fuzzy solution of the NVFFIDE is presented. The convergence of the proposed method is proved. A numerical example is given to demonstrate the validity and applicability of the proposed technique.

II. Textbooks

E19.1. P. Georgieva, **A. Georgieva**, E. Dimitrova, Mathematics, Blakom publishing house, 2004.

The proposed textbook contains lectures and exercises, consistent with the program for bachelor’s degree in the discipline "Higher Mathematics" at the Faculty of Technology at the University of Food Technologies - Plovdiv.

The theoretical part of this textbook contains definitions, basic properties and applications of important mathematical concepts used in a number of general and specialized courses in various disciplines. There are exercises that follow the presented topics and help to fully master the introduced concepts.

The textbook provides information on the capabilities and rules of use of the DIRAVE computer algebraic system and contains problems that can be conveniently solved with it.

E19.2. **A. Georgieva**, *A course in Ordinary Differential Equations* University publisher „Paisii Hilendarski“, 2023, ISBN 978-619-202-830-5, (in Bulgarian).

This Course is a collection of lectures on the fundamental theory of ordinary differential equations, focusing on the classical aspect of the theory as well as some of its applications.

The content of this course meets the standard requirements for teaching undergraduate students in the following majors: Mathematics; Applied Mathematics; Business Mathematics; Mathematics, Informatics and Information Technologies and Information Technologies, Mathematics and Educational Management at the Faculty of Mathematics and Informatics at Plovdiv University.

In addition to the theory, the textbook also contains methods for solving the main types of ordinary differential equations and can be useful to students from other specialties who study disciplines containing topics within this course or related to the material presented here.

Signature:

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