REVIEW

from Vasil Georgiev Angelov, D.Sc., Ph.D.,
Professor at the University of Mining and Geology "St. Ivan Rilski"

of the materials submitted for participation in the competition
for the academic position of **"professor" at**
Plovdiv University "Paisii Hilendarski"

by: Field of higher education 4. Natural Sciences, Mathematics and Informatics,
Professional field 4.5 Mathematics;
Differential Equations

In the competition for "professor", announced in the State newspaper, issue 92 of 18.11.2022 and on the website of Plovdiv University "Paisii Hilendarski" for the needs of the Faculty of Mathematics and Informatics, as the only candidate is Assoc. Prof. Atanaska Tencheva Georgieva, PhD, from Plovdiv University "Paisii Hilendarski".

1. General presentation of the received materials

By order № RD-21-338 of February 15, 2023 of the Rector of Plovdiv University "Paisii Hilendarski" (PU) I was appointed a member of the scientific jury of the competition for the academic position "Professor" in PU in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.5 Mathematics, Differential Equations, announced for the needs of the Faculty of Mathematics and Informatics (FMI). The only candidate for participation in the announced competition has submitted documents: Assoc. Prof. Dr. Atanaska Tencheva Georgieva from the University of Plovdiv. The set of paper materials presented by Assoc. Prof. Georgieva is in accordance with the Regulations for the Development of the Academic Staff of the University of Plovdiv and includes all the necessary documents. To participate in the competition, Assoc. Prof. Atanaska Georgieva has submitted a total of 23 scientific publications and two textbooks, not used in previous procedures.

2. Brief biographical data

Assoc. Prof. Atanaska Georgieva, PhD, completed her higher education – a full 5-year course in Mathematics and Informatics at FMI at the University of Sofia "Kliment Ohridski" in 1991. In 2012 she defended her dissertation on *"Lp-equivalence between impulse differential equations"* and research supervisor Prof. Stepan Kostadinov, D.Sc. at the FMI at PU.

From 1993 to 2012 she passed all the degrees of assistant, and from 2012 she is Associate Professor at the Faculty of Mathematics at the University of Plovdiv at the Department of Mathematical Analysis.

3. General characteristics of the candidate's activity

Evaluation of educational and pedagogical activity

The educational and pedagogical activity of the candidate is related to the education of students of bachelor's and master's specialties at the Faculty of Mathematics and Informatics at the University of Plovdiv "Paisii Hilendarski" and the education of doctoral students at FMI. Over the years, Assoc. Prof. Georgieva has given lectures and exercises in various disciplines at the FMI, most of which are lecture courses created by her.

Assoc. Prof. Georgieva is the research supervisor of:

1) Lozanka Spiridonova Trenkova – in 2015, she successfully defended her dissertation on "Abstract equations of the Volterra type and applications" to obtain the educational and scientific degree "doctor", field of higher education: 4. Natural sciences, mathematics and informatics; professional direction 4.5. Mathematics; PhD program Differential Equations;
2) Iva Todorova Naydenova – successfully defended her dissertation in 2022 on the topic "Approximate solutions of some classes of fuzzy integral equations" to obtain the educational and scientific degree "doctor", field of higher education: 4. Natural sciences, mathematics and informatics; professional direction 4.5. Mathematics; PhD program Differential Equations;
3) Mira Lachezarova Spasova – dismissed with the right of defense in 2023.

The extracurricular activity of the candidate includes scientific supervision of a number of graduate students, as well as numerous reviews of diploma theses.

Candidate Assoc. Professor A. Georgieva is the author of two textbooks – one on "Mathematics" with two co-authors and one independent on "Ordinary Differential Equations". The textbooks presented for the procedure are used when reading lectures by the author of the Mathematics and Applied Mathematics majors. She also lectures in Ordinary and Partial Differential Equations, Mathematical Models in Physics, Mathematical Analysis 1 and 2, School Analysis Course, and majoring in Software Engineering – Mathematical Analysis. All these courses are within the curriculum of "Paisii Hilendarski" PU.

The content of the first textbook "Mathematics" includes the basic elements of linear algebra and analytic geometry, as well as the basics of mathematical analysis of functions of one variable. The second textbook contains a basic course in ordinary differential equations and ends with the application of basic software packages for the numerical solution of ordinary differential equations.

Evaluation of scientific and applied research activities

The overall volume of the scientific works of the candidate Assoc. Prof. Georgieva includes a total of **72** works, of which **69** scientific publications and **3** textbooks. To participate in this competition, she has selected **23 scientific publications** and **2 textbooks**, which are not presented for the acquisition of the educational and scientific degree "Doctor" (2009), or for the academic position of "Associate Professor" (2012).

From the presented **23** scientific publications all are in English; all have been published in peer-reviewed journals; each of the presented publications is indexed in at least one of the leading world-famous databases with specialized scientific information, as follows:

1. **Georgieva A**., Kostadinov S., Stamov G., Alzabut J.
(IF=0.760, Q2), (Zbl: 1347.34098), (SJR=1,168).

2. Zahariev A., Zlatev S., **Georgieva A**.
(IF=0.198, Q4), (Zbl: 1313.34198), (SJR=0,205).

3. Bohner M., **Georgieva A.,** Hristova S.
(IF=1.232, Q1), (SJR=0,406).

4. Georgieva A., Kiskinov H., Kostadinov S., Zahariev A.
(IF=0.419, Q3), (Zbl: 1288.34053), (SJR=0,523).

5. Georgieva A., Kiskinov H., Kostadinov S., Zahariev A.
(IF=0.817, Q2), (Zbl 1324.34117), (SJR=0,557).

6. Zahariev A., **Georgieva A.**, Trenkova L.
(IF=0.773, Q2), (Zbl 1372.35318), (SJR=0,395).

7. Georgieva A., Trenkova L., Cholakov S.
(Zbl: 1331.47080).

Georgieva A., Trenkova L., Atanasova P.
(Zbl: 7360320).

Enkov S., **Georgieva A.**, Nikolla R.
(H Index 37**,** SJR=0,165, Web of Science).

Enkov S., **Georgieva A.**
H Index 37, SJR=0,165, Web of Science), (Zbl 1466.65227).

11. **Georgieva A.**, Naydenova I.
(H Index 37, SJR=0,165, Web of Science), (Zbl 1465.65168).

12. **Georgieva A.**, Pavlova A., Naydenova I.
(H Index 37**,** SJR=0,246, Web of Science).

13. Atanasova P., **Georgieva A.**, Konstantinov M.
(IF=1.53, Q2), (Zbl 1391.34095), (SJR=0,719, Scopus**).**

14. **Georgieva A.**, Enkov S.
(H Index 47**,** SJR=0,182, Web of Science).

15. **Georgieva A.**, Pavlova A., Enkov S.
(SJR=0, 246, Web of of Science).

16. **Georgieva A.**, Alidema A.
(SJR= 0,246, Web of Science**).**

17. Naydenova I., **Georgieva A.**
(H Index 47, SJR=0,190, Web of Science).

18. **Georgieva A.**, Melemov H.
(IF= 0.5, Q4), (SJR=0,208).

19. **Georgieva A.**, Naydenova I.
(H Index 75, SJR=0,189, Web of Science).

20. **Georgieva A.**, Pavlova A., Trenkova L.
(H Index 62, SJR=0,185, Web of Science).
21. **Georgieva A.**, Naydenova I.
(H Index 75, SJR=0,189, Web of Science**).**
22. **Georgieva A.**, Naydenova I.
(H Index 75, SJR=0,189, Web of Science).
23. **Georgieva A.**

(H Index 75**,** SJR=0,189, Web of Science).

Among all the **23** publications presented, **1** is independent, **9** are with two authors, **10** – with three authors and **3** – with four authors. The number of co-authors is **18**.

Each of the **23** publications presented is indexed in at least one of the leading worldrenowned databases of specialized scientific information, as follows:

- **8** are in journals with impact factor (IF), total IF = 7.02, of which 1 is in Q1; 4 are in Q2; **1** is in Q3 and **2** are in Q4;
- **18** are indexed in the Web of Science;
- **20** are indexed in SCOPUS;
- **21** have SJR, total SJR = 6.138;
- **10** are referred to in Zentralblatt Math;

In addition, it can be noted that Associate Professor Dr. Georgieva participated in national, regional and university research projects, as well as in international conferences. He is a member of SIAM and AMS.

Contributions (scientific and applied) and citations

I agree with the self-assessment of the candidate that thematically the main scientific and scientific-applied contributions of the candidate in the presented scientific papers can be divided into the next three directions:

Direction A – Approximate solutions of fuzzy integral equations

a) Analytical solutions of fuzzy integral equations

In this group are the articles [B4.1] - [B4.5] and [G7.18]. In the publications [B4.1] - [B4.5] analytical solutions of two-dimensional fuzzy integral equations were found, and in work [G7.18] an analytical solution of a fuzzy Volterra-Fredholm integro-differential equation was obtained. In article [B4.1], the approximate solution of a two-dimensional fuzzy functionalintegral equation of Volterra was obtained using the method of homotopic perturbations. Sufficient conditions for the existence of a unique solution of the considered equation have been formulated. A fuzzy homotopic perturbation method was used and applied to find the analytical solution of the studied equation. The convergence of the proposed method is proven and an estimate of the error between the exact and the approximate solution is found. In the articles [B4.2] and [B4.4], a nonlinear two-dimensional fuzzy Volterra-Fredholm integral equation with partial integrals is studied. A fuzzy variant of Adomian's method was constructed and applied to find the approximate solution of the studied equation. Sufficient conditions for the existence of a unique solution of the considered equation are proposed and the convergence of the method is proved. An error estimate has been obtained. Sufficient conditions for the equivalence of the fuzzy variants of the homotopic perturbation method and the Adomian method for the nonlinear two-dimensional fuzzy Volterra-Fredholm integral equation with

partial integrals are found. In the publications [B4.3], [B4.5] and [G7.18], using the method of homotopy analysis, the approximate solutions of the two-dimensional fuzzy Volterra-Fredholm integral equation, of the two-dimensional fuzzy Volterra-Fredholm integral equation of partial integrals, as well as of the Volterra-Fredholm integro-differential equation. A fuzzy homotopy analytical method was constructed, with which the approximate solutions of the considered equations were found. Sufficient conditions for the existence and uniqueness of the solution of the investigated equations were found and the convergence of the proposed method was proved. Error estimates are received.

b) Numerical solution of fuzzy integral equations

Iterative methods using fuzzy cubic and quadrature formulas are proposed in the works of this group. The numerical solutions of two-dimensional fuzzy integral equations [G7.10], [G7.13] - [G7.15] and [G7.17] were found, and in [G7.9] and [G7.11] – of fuzzy integral-functional equations of Hammerstein and Urison-Volterra type. Sufficient conditions for the existence of a unique solution of the studied equations were found and the convergence of the proposed methods was proven.

In the articles [G7.10], [G7.13] and [G7.17], a nonlinear two-dimensional fuzzy Hamerstein-Fredholm functional-integral equation is considered. The iterative procedure in [G7.10] is based on fuzzy Haar arcs, and in [G7.13] and [G7.17] a fuzzy rectangle cubature formula is used. In papers [G7.10] and [G7.17] error estimates are obtained for the class of fuzzy Lipschitz functions, and in [G7.13] the error estimate is given in terms of the modulus of continuity.

In article [G7.9], a nonlinear fuzzy functional-integral equation of Hammerstein was investigated, and in [G7.14] – a nonlinear two-dimensional fuzzy functional-integral equation of Fredholm. The iterative methods use the optimal fuzzy quadrature and cubature formulas for the class of fuzzy Lipschitz functions. The robustness of the methods regarding the choice of the first approximation is investigated. An error score is given.

In article [G7.11], a nonlinear fuzzy functional integral equation of Urison-Volterra is considered. The fuzzy trapezoidal quadrature formula is applied. The stability of the method with respect to the first approximation is investigated. An error estimate is obtained for the class of fuzzy Lipschitz functions.

In article [G7.15], a nonlinear two-dimensional fuzzy integral equation of Urison is considered. The iterative method is based on Simpson's fuzzy cubic formula. An estimate of the error is given in terms of the modulus of continuity. The stability of the method with respect to the first iteration was investigated.

Direction B – Ordinary differential equations

a) Ordinary differential equations in Banach spaces

In this group are the articles [G7.1], [G7.2], [G7.6], [G7.12].

Using the Schauder-Tikhonov fixed point theorem, sufficient conditions for the existence of Lp(k)-equivalence between a linear and a nonlinear perturbed impulse differential equation with an unbounded linear part in an arbitrary Banach space were found in work [G7.1].

The obtained theoretical results are illustrated with an example of the partial differential equations of the parabolic type.

In paper [G7.2], generalized ψ-exponential and ψ-ordinary dichotomy for homogeneous linear differential equations in Banach space are considered. With these two generalizations of the dichotomy, sufficient conditions for the existence of ψ-bounded solutions of the inhomogeneous equations are found. The roughness of the ψ-dichotomy was also investigated.

Nonlinear differential equations with ψ-exponential and ψ-ordinary dichotomous linear part in Banach space are considered in work [G7.6]. Using Banach's fixed point principle, sufficient conditions for the existence of ψ-bounded solutions of these equations on R and R+ have been found.

In article [G7.12], the notion of Lp(h,k)-solution of a linear momentum differential equation in Banach space was introduced. Sufficient conditions for the existence of such solutions have been found. Possible applications of linear pulse control systems are reviewed. A numerical example is given, confirming the obtained theoretical results.

b) Ordinary differential equations in finite dimensional spaces

In this group are the articles [G7.3], [G7.4], [G7.16].

In paper [G7.3], parametric robustness for nonlinear differential equations with "maxima" is investigated. Sufficient conditions for parametric stability as well as uniform parametric stability are obtained based on Razumihin's method. Two different types of Lyapunov functions are applied. A comparison with scalar ordinary differential equations is given.

In paper [G7.4] explicit and easily verifiable sufficient conditions for the existence of several types of non-oscillating solutions of a linear system with a delayed argument of neutral type with distributed delay are found. The results are proved by numerical technique. They are also applicable in the case of non-monotonic measures.

In article [G7.16], an algorithm for finding exact polynomial solutions of a certain class of linear differential equations on the group sl(2, R) is proposed. This linear algorithm is implemented using the Lie algebraic technique. The solutions are constructed in the form of a finite product of exponentials of nilpotent elements in the Lie algebra sl(2, R).

Direction C – Integral equations

In this group are the articles [G7.5], [G7.7],[G7.8].

In work [G7.5], a generalization of linear and nonlinear Volterra integral equations of the second order, when the independent variable belongs to an arbitrary non-compact metric space, is considered. Sufficient conditions for the existence of solutions of Volterra-type integral equations in the inhomogeneous case have been obtained. Applications of the obtained results for integral inequalities are given.

In article [G7.7] a generalization of linear and nonlinear Volterra integral equations of the first and second-order in the case when the independent variable belongs to an arbitrary Hausdorff space is considered. Sufficient conditions for the uniqueness of the solution of the

Volterra integral equation of the first kind have been found. As an application of this result, the existence of a solution to a second-order nonlinear Volterra integral equation is proved.

In article [G7.8], a numerical method for finding a numerical solution of a perturbed linear integral equation of Volterra is proposed. Sufficient conditions for the existence and uniqueness of a continuous solution in a finite and closed interval of the studied equation are found. The convergence of the numerical method is proven. Numerical examples are given to show the efficiency and accuracy of the method.

My general impression of the scientific and applied scientific contributions is that they are new and meaningful.

The presented list of noted citations includes **32** citations of **19** scientific papers. The citations are essential and are not explicit or implicit self-citations. All **32** citations had not been used by the candidate in previous procedures.

The **Hirsh index** of the candidate in Google Scholar is **12**, which is a very good certificate for her scientific work.

Regarding **the minimum national scientometric requirements** for holding the academic position "Professor the number of points is greater than or equal to the minimum requirements.

Regarding **the additional requirements of FMI** for holding the academic position "Professor": **23** publications and **2** textbooks are presented, with a minimum requirement of 20 publications and 1 textbook. All publications are in peer-reviewed journals, with a minimum requirement of at least 12 being in journals. There are **8** articles published in journals with an impact factor, with a minimum requirement of 8 articles. Evidence of **32** citations is provided, with a minimum requirement of at least 20 citations. These citations are of articles that do not participate in the doctoral dissertation and in the competition as an associate professor. There is a scientific supervision of **2** successfully defended doctoral students, with a minimum requirement of 1 defended doctoral student. This review shows that all additional requirements are met, and not at a minimum.

4. Assessment of the personal contribution of the candidate

Despite the fact that the presented publications are co-authored, there is no doubt about the personal participation and contribution of the candidate in the scientific papers submitted for the competition. I did not find any evidence of plagiarism.

5. Critical remarks and recommendations

In the introductory notes of most articles, it is not noted what type the nonlinearities are in the different classes of differential and integral equations. Here we are talking about Lipschitz nonlinearities, where the proof technique works.

6. Personal impressions

I have known Atanaska Tencheva Georgieva for ten years professionally and I have good impressions of her results and wide scientific interests. Assoc. Prof. Dr. Georgieva is an

established scientist and specialist in the field of differential equations and mathematical analysis. She is a supervisor of two successfully defended PhD students.

CONCLUSION

The documents and materials presented by Assoc. Prof. Atanaska Georgieva, PhD meet all the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria (ZRASRB), the Rules for Implementation of ZRASRB and the relevant Rules of Paisii Hilendarski University.

The candidate in the competition has submitted a sufficient number of scientific papers published after the materials used in the defense of the PhD and the competitions for the academic positions of "Chief Assistant" and "Associate Professor". In the works of the candidate there are original scientific and applied contributions that have received international recognition, which is unequivocally evidenced by the large number of citations. Her theoretical developments have practical applicability, and some of them are directly oriented to the educational work. The scientific and teaching qualification of Assoc. Prof. Dr. Atanaska Georgieva is undoubted.

The results obtained by Assoc. Prof. Georgieva in the research and teaching activities exceed the minimum national requirements and the additional requirements of the FMI, adopted in connection with the Regulations of the PU for application of ZRASRB.

Based on the written above, I give my **positive assessment** and **recommend** the Scientific Jury to propose to the Faculty Council of the Faculty of Mathematics and Informatics to elect Assoc. Prof. Atanaska Tencheva Georgieva, PhD to the academic position of **"Professor"** at Paisii Hilendarski University of Plovdiv in: field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.5 Mathematics (Differential Equations).

07.04.2023 **Reviewer:** .....

. **Prof. Vasil Angelov, D.Sc., Ph.D**