REVIEW

in a competition for the academic position of "professor" in the field of higher education 4. Natural Sciences, Mathematics and Informatics, professional field 4.5 "Mathematics", scientific specialty "Computational Mathematics", announced by the Technical University - Gabrovo in the State Gazette no. 50 of June 15, 2021, for the needs of the Department of Mathematics with candidate Assoc. Prof. Todor Dimitrov Todorov, Ph.D.

Reviewer: Prof. Svetoslav Ivanov Nenov, Ph.D., UCTM-Sofia

1. General provisions and biographical data

This review is based on Order No. 3-01-396/29.09.2021 of the Rector of the Technical University - Gabrovo and a decision of the first meeting of the Scientific Jury (Protocol 60/28.09.2021) under this order. In writing the review I have adhered to the Law for the Development of Academic Staff in the Republic of Bulgaria (ZRASRB) and the Rules of the Regulations for obtaining scientific degrees and holding academic positions at the Technical University - Gabrovo on the application of ZRASRB.

Documents were submitted by the only one candidate Assoc. Prof. Todor Dimitrov Todorov, Ph.D.. Accordingly, I have received the following documents:
1. application to the rector for admission to the competition;
2. a copy of a state gazette with the announcement of the competition;
3. diploma for completed higher education;
4. diploma for educational and scientific degree "doctor";
5. certificate for holding an academic position "associate professor";
6. inapplicable/inappropriate in numbering;
7. autobiography;
8. list of the publications for participation in the competition;
9. list of the publications submitted for acquiring the educational and scientific degree "Doctor";
10. list of publications for holding the academic position "associate professor";
11. not applicable/inappropriate in numbering;
12. list of citations;

13. information about the impact factor of the magazines in which there are publications of the candidate;
14. not applicable/inappropriate in numbering ;;
15. author's reference for the contributions in the scientific works and habilitation extended reference;
16. summaries of the works;
17. reference for fulfillment of the minimum national requirements and the requirements of the Regulations for acquiring scientific degrees and holding academic positions at the Technical University - Gabrovo for holding the academic position "professor";
18. the summaries of the peer-reviewed publications;
19. declaration for authenticity of the provided information;
20. list of published textbooks;
21. not applicable/inappropriate in numbering;
22. management of projects and contracts;
23. list of invitations for review;
24. documents for defended doctoral student.

Assoc. Prof. Todor Dimitrov Todorov was born on October 12, 1962. He graduated in Mathematics at Plovdiv University "Paisii Hilendarski" with a qualification – Mathematician.

Since 1986 until 1989 is a teacher of mathematics at the "Maxim Raikovich" School of Economics.

In 2001, the Higher Attestation Commission at the Council of Ministers of the Republic of Bulgaria awarded him the educational and scientific degree "Doctor" in the scientific specialty 01.01.09 – Computational Mathematics based on a defended dissertation on "Isoparametrics in the finite element method" (Commission 01 , Protocol 11 of 26.10.2001).

The candidate works consecutively as an assistant, senior assistant and chief assistant at the Technical University - Gabrovo in the period until 2006.

In 2006, the Higher Attestation Commission at the Council of Ministers of the Republic of Bulgaria awarded him the scientific title "Associate Professor" in the scientific speciality 01.01.09 – Computational Mathematics (Commission 01, Minutes 2 of 10.03.2006).

The candidate is the head of the Department of Mathematics, Informatics and Natural Sciences at the Technical University – Gabrovo since 2020.

He speaks English. Technical/computer competencies - multi-paradigm programming language: Wolfram Language.

Under his supervision, a dissertation has been defended on theme "Study of voice control methods" in 1986. (Diploma 0075/13 July 2018).

It is evident from the attached documents that Assoc. Prof. Todor Todorov has reviewed numerous articles in a number of prestigious international journals.

The candidate's scientific interests are extremely multifarious, but I would point out three areas: spatial-temporal discretization of bounded areas (including classical triangularization methods, semi-discrete discretization methods, etc.), finite element method for different classes of equations and numerical analysis of neural networks and voice recognition systems.

A simple proof for the achievements of Assoc. Prof. Todor Dimitrov Todorov is the number of his citations (more than 60, without self-citations or citations by co-authors), a number of them in journals with Impact Factor or journals referred in Scopus. Of course, another proof is the number and scientific level of the journals in which he has published. As can be seen from document 13. Information on the impact factor of journals in which the author has publications, most of these journals are with Impact Factor (many of them in Quartile 1) or journals referred in Scopus.

2. Description of the submitted materials

The candidate, Assoc. Prof. Todor Todorov, has submitted for review 34 publications: A29-A62 (here I use the indexation and enumeration in the candidate's presentation).

All the minimum requirements of TU-Gabrovo for obtaining the academic position of "professor" are met: a minimum of 30 publications, of which at least 5 are independent and 3 with Impact Factor. In fact, there are 34 publications, with:
  1. Nine publications have an impact factor: A29, A35, A40, A46, A47, A49, A50, A52 and A55.

2. Nine publications are independent: A29, A31, A34, A35, A36, A40, A46, A48, A56.
3. Three individual articles in Quartile 1 (Q1) journals on the Web of Science: A35, A40 and A46.

Assoc. Prof. Todor Todorov, presented 4 published textbooks/books E1-E4 (minimum requirements of TU-Gabrovo for holding the academic position of "professor": 2).

The candidate is the manager of 7 scientific projects under a contract with the Technical University - Gabrovo at the Scientific Research Fund (minimum requirements of TU-Gabrovo for holding the academic position "professor": 3).

More than 60 citations are presented, if necessary 20, according to the requirements of TU-Gabrovo.

It follows from the above findings that the candidate Assoc. Prof. Todor Todorov fully satisfies, and in many ways presents more than the minimum national requirements for holding the academic position of "professor".

Therefore, I accept the reference for fulfillment of the minimum requirements (document 17, submitted by the applicant).

3. General characteristics of the research works of the candidate

According to the submitted documents, it is evident that Assoc. Prof. Dr. Todor Todorov is an author of 4 textbooks:

E1. T. Todorov, Textbook of Competitive Mathematics, second edition, EX-PRESS, Gabrovo, 2016, 107 pages, ISBN 978-954-436-050-4.
E2. TD Todorov, Textbook of Higher Mathematics Part Two, Second Edition, EX-PRESS, 2017, 199 pages, ISBN 978-954-683-502-4.
E3. TD Todorov, Textbook of Higher Mathematics Part Three, EX-PRESS, 2017, 153 pages, ISBN 978-954-490-546-0.
E4. TD Todorov, Textbook of Higher Mathematics Part One, EX-PRESS, 2019, 188 pages, ISBN 978-954-490-651-1.

The presented textbooks consider the main sections of the materials in linear algebra, analytical geometry, real analysis of functions of one or more

variables, differential equations, etc. Numerous detailed tasks and examples are given in the separate sections of the textbooks. The materials in the textbooks are clearly presented and are fully accessible to students. Apart from the fact that the textbooks provide an opportunity for self-preparation, they can also be used as reference tools in the research activity of the students both from TU-Gabrovo and from other universities.

The candidate has submitted 8 publications (A35, A47, A49, A50, A55, A60 and A61) for habilitation work. All articles are cited in Scopus, Elsevier B.V. Five of the articles were published in journals with impact factor and quartile 1. The total impact factor of the articles presenting the habilitation thesis is 10,185.

The topic of the publications presenting the habilitation work is related to methods for breaking limited areas in the n-dimensional Euclidean space. The main contribution of the candidate in the habilitation work can be divided into the following 4 points:

1. Algorithm for a triangle of 4d connected polyhedra, cf. A47. The author of A47 shows that the proposed algorithm can be used for n-dimensional Euclidean spaces. A theorem has been formulated (and proved) that represents tesaract $T = \left| \left| x_1, x_2, x_3, x_4 \right| \in R^4 : -1 \le x_i \le 1 \right|$ as a union of pentatopes (ie 4-simplexes). Of course, the uniform division of the pentatope tesract is valid only for two-dimensional and four-dimensional space.

2. In Article A60, the authors show that any n-dimensional bipyramid can be divided into $2^{n-4}(n-2)!$ Freudental element ($n>3$). The obtained result is directly related to the application of the finite element method. Let me point out that the classic result of Freudental is that an n-dimensional cube can be represented as a union of n! elementary elements. Obviously, the candidate's result is more specific at "small" n ($3 <n <11$).

3. In three-dimensional space, series of successive triangulations are considered, in which each edge of each element in each level is divided into two equal parts (into three equal parts), cf. A35 and A50. A comparison with known methods for "thickening" triangulations is presented.

4. When triangularizing the canonical domains in n-dimensional Euclidean space, new simplicial classes are obtained and studied,

cf. [A55]. Various theorems on the rate of divergence of a series of simplexes have been proved. Invariant simplexes with respect to different compression methods were investigated.

The results obtained by the candidate in the articles (presenting the habilitation work) are significant and have a direct direction to the triangolarization of the bounded domains in the *n*-dimensional Euclidean space and the application of the finite element method in them.

The presented publications A39, A42, A46, A48 and A52 are related to the study of nonlinear boundary value problems containing a non-local multiplier. Differential equations with a second-order linear operator and p-Laplacian equations are considered. An algorithm is used to study the set tasks, including discretization of the problem. A radially basic neural network is presented and used. Different properties of the so proposed neural network and the finite element method have been studied, where different advantages of one or the other method are presented.

The separate publications A29, A31 and A56 are related to a linear telegraphic equation with periodic boundary conditions, a reaction-diffusion equation and a problem for calculating the flow through a two-dimensional closed continuous Lipschitz boundary. The first two tasks are studied by multi-network methods. For the reaction-diffusion equation and for the problem of calculating the flow through a two-dimensional closed continuous boundary, they were studied in areas with a complex boundary.

The presented publications (with respective candidate reference numbers) A58, A59 and A62 are related 4d transition elements and in particular the construction of quadrature formulas for hypercubic dominant networks. The main strategy of the authors is related to the construction of an orthonormal basis of Jacobi polynomials on a cubic pyramid. The least squares method gives quadrature formulas with an algebraic degree of accuracy of 12. It is impressive that the number of algebraic operations is monitored in order to minimize the computational procedures and preserve the spectral properties of the boundary value problem.

Articles A32, A33, A34, A36, A51, A53, A54, A57, and A62 discuss some existing methods for constructing series of successive triangulations. New methods for such constructions have also been proposed - a series of hierarchical conformal hybrid sequential triangulations of 4d canonical

domains have been constructed. Separation operators are defined that generate only tesseract, pyramidal and bipentatope elements. A method for thickening 3d-pyramidal networks of finite elements has been studied. Freudenthal's algorithm for optimal separation of a hypercube in n-dimensional Euclidean space has been studied. It has been shown that for some n "better" divisions of Freudent's share can be defined. Various compression strategies for triangulation of spheres, three-dimensional areas with a spherical boundary, and three-dimensional canonical areas are analyzed.

Articles A37, A38, A41, A43, A44, A45 and A52 address various issues in the theory of neural networks and voice recognition systems. In particular: application of neural networks for solving differential equations and classification of voice signals and analysis of the speed of deep machine learning through multilayer neural networks. A new stochastic classifier is obtained. A successful classification was performed using a new two-layer Boltzmann machine.

4. Pedagogical activity of the candidate

The candidate has a long and successful teaching career. In the last five years alone, he has lectured on bachelor's and master's degrees in basic mathematical disciplines (all together hours, excesses the requirements of the law).

The above circumstances characterize Assoc. Prof. Todor Todorov as an established lecturer with very good pedagogical schooling.

5. The basic scientific contributions

I accept the candidate's reference for the contributions in the scientific works (presented under number 15) to the scientific contributions in the presented works:
1. A dissipative algorithm for separation of convex polytopes has been developed.
2. Consecutive divisions have been obtained into canonical four-dimensional domains, which are unfavorable in terms of the measure of degeneracy and the number of similarity classes.

3. One of the main problems of the finite element method in multidimensional spaces is solved - conformal connection of hypercubic and simplicial networks.
4. When triangulating canonical domains in n-dimensional Euclidean space, new simplicial classes are obtained and studied.
5. In the three-dimensional space, series of successive triangulations are considered, in which each edge of each element in each level is divided into two equal parts (into three equal parts).
6. A new iterative algorithm for detecting the intersection of convex polytopes is obtained.
7. On 4d transition elements are developed: finite element bases, orthogonal bases and quadrature formulas.

To the scientific-applied contributions I refer the obtained results related to the developed numerical methods and algorithms for classification of voice signals, the constructed neural networks for solving nonlinear nonlocal boundary value problems.

6. Significance of contributions to science and practice

The obtained scientific and scientific-applied contributions are important for the theory and applications of differential equations at all. A simple proofs of this fact is the number of prestigious publications and forums where these results are presented, as well as the numerous citations (including in concrete based citations) of the works of the candidate by foreign and Bulgarian scientists and specialists in the field of differential equations and applications.

7. Criticism and recommendations

I have not any essential critical remarks or recommendations that decry the excellent impressions related to the scientific and teaching activities of the candidate.

8. Personal impressions and opinion of the reviewer

I do not know the candidate personally, but after reading his articles and textbooks, I think that his carriers as a scientist and as a lecturer are consistent and convincing to occupy the academic position of "professor".

CONCLUSION

The above analysis and the documents attached to the procedure show the following. The presented scientific papers and text-books, as well as the data on the overall scientific and teaching activity of the candidate, characterize him as an active researcher and a very good university lecturer.

The scientific works of the candidate meet the high scientific and technical level and contain significant scientific contributions in theory to the differential equations and their applications. The author not only summarizes and applies certain results, but also obtains new, original results both in the theory and in the applications of differential equations.

The results obtained by the author are known to the world scientific community in the field and have received high recognition there. The candidate's works continue to be regularly cited and used by other scholars at Bulgaria and abroad. Thus, the overall scientific and teaching activities of the candidate fully meet the requirements of the Law for the Development of Academic Staff in the Republic of Bulgaria and the Rules for Development of Scientific Degrees and Occupation of Academic Positions at the Technical University – Gabrovo.

Having in mind the facts and all commnets described above, I strongly suggest the Scientific Jury to highly appreciate the candidacy of Assoc. Prof. Todor Dimitrov Todorov, Ph.D. and to recommend that he be elected to the academic position of "Professor".

Reviwer: /signature/

October 20, 2021   (Prof. Svetoslav Nenov, Ph.D.)