

# OPINION

by

**Prof. D.Sc. Eng. Raycho Todorov Ilarionov,**

*Technical University of Gabrovo,*

*Department of Computer Systems and Technologies*

**concerning the scientific works submitted for participation in a competition for awarding the academic position of "Professor" in higher education area 4. Natural Sciences, Mathematics, and Informatics, professional field 4.5 Mathematics, specialty "Computational Mathematics" announced in the State Newspaper issue 50, June 15, 2021 with the only candidate Assoc. Prof. Dr. Todor Dimitrov Todorov**

## **1. Brief biographical data**

Assoc. Prof. Dr. Todor Dimitrov Todorov was born in 12.10.1962.

In 1980, he graduated from the Mathematical High School - Gabrovo and continued his education at Plovdiv University "Paisii Hilendarski". He began his career as a teacher in mathematics at the Maxim Raikovich School. On October 6, 1989, he was elected an Assistant Professor in the Department of Mathematics at VMEI-Gabrovo.

In 1993 the candidate was enrolled in a doctoral program and in 2001 he defended a Ph.D. thesis on "Isoparametricity in the finite element method" in the scientific specialty 01.01.09 "Computational Mathematics". In 2006 he was elected by the Higher Attestation Commission as an associate professor in the Department of Mathematics at the Technical University of Gabrovo in the scientific specialty 01.01.09 "Computational Mathematics". Since July 2020, Assoc. Prof. Dr. Todor Todorov is the head of the Department of Mathematics, Informatics, and Natural Sciences.

## **2. General description of the submitted scientific achievements**

The candidate Assoc. Prof. Dr. Todor Todorov participates in the competition for "professor" with:

- publications equivalent to habilitation work - 7 papers;
- other publications - 27 papers;
- four textbooks.

The publications can be classified as follows.

### **By type**

- twenty-four journal papers;
- ten reports at national and international conferences.

### **By significance**

**Impact factor publications related to the competition for the academic position of "professor":** 9 papers.

### ***Distribution by quartiles***

**Publications indexed in the first quartile of the Web of Science:** 7 papers

- three standalone papers A35, A40 и A46;
- four joint papers A47, A50, A52 и A55.

**Publications indexed in the fourth quartile of the Web of Science:** 2 papers

- one standalone paper A29 and
- one joint paper A49.

The paper with the highest impact factor is A52. Its impact factor is 4.774.

**Publications indexed in Scopus without an impact factor:** 5 articles  
A38, A42, A45, A60 and A61.

***Geographically:***

- papers in foreign journals - 17 papers - A29, A31, A35, A39, A40, A42-A48, A50, A51, A52, A55, A62;
- papers in proceedings of international scientific conferences abroad – 4 papers  
A38, A41, A60, A61;
- papers in Bulgarian scientific journals - 7 papers  
A30, A34, A36, A37, A49, A56, A57;
- papers in proceedings of international scientific conferences in Bulgaria – just one A32;
- papers in proceedings of national scientific conferences, sessions, and seminars - 5 papers A33, A53, A54, A58, A59.

***With respect to the language they are written:***

- in English - 33 papers, all except A30;
- in Bulgarian only A30.

***By the number of co-authors:***

- standalone - 9 papers A29, A31, A34, A35, A36, A40, A46, A48, A56;  
four of them are indexed in the Web of Science;  
A35, A40 и A46 are indexed in the first quartile, and  
A29 is indexed in the fourth quartile;
- with one coauthor - 16 papers A30, A39, A44, A45, A47, A49, A50, A51, A53, A54, A55, A57-A61;
- with two coauthors - 5 papers A32, A33, A38, A42, A52;
- with three or more coauthors – 4 papers A37, A41, A43, A62.

***Peer review***

The candidate's scientific works are in journals with an impact factor, in national and international journals, and they are presented at national and international conferences in the country and abroad, where all publications are reviewed in advance. The textbooks have also been peer-reviewed.

### **3. The reputation of the candidate among members of the corresponding scientific community**

The scientific works written by Assoc. Prof. Todor Todorov have been published in world-famous journals with publishers like Elsevier, Springer, Oxford University Press, Emerald. A list of 68 citations is presented, 44 of which are indexed in the Web of Science.

This gives me a reason to conclude that the scientific achievements of the candidate are known to the leading experts in the finite element method and the theory of multidimensional polytopes.

### **4. General characteristics of the candidate's activity**

#### ***4.1. Educational and methodical activity***

Associate Professor Dr. Todor Todorov is an established lecturer with more than 30 years of research and teaching experience at the Technical University of Gabrovo. The educational and pedagogical activity of the candidate is at a high level, which corresponds to the academic position of "professor". He is a leading lecturer in two subjects at the undergraduate level: Higher Mathematics first part and Higher Mathematics second part. Associate Professor Dr. Todor Todorov is the author of four textbooks, cited above. These

textbooks have been used for the training of students from the Technical University of Gabrovo. One Ph.D. thesis has been developed and defended under Assoc. Prof. Dr. Todor Todorov's supervision.

#### **4.2. Scientific and applied research activities**

Assoc. Prof. Todor Todorov's research interests are in the area of the finite element method and its application for solving nonlinear nonlocal boundary value problems, elliptic boundary value problems, problems for determining eigenvalues of differential operators, analysis of neural networks, and development of systems for voice recognition. Assoc. Prof. Todorov has significant achievements in the theory of multidimensional polytopes directly related to the geometric foundations of the finite element method.

Assoc. Prof. Todorov's scientific works submitted for the competition for the academic position "Professor" (24 journal papers, 10 conference proceedings papers, and 4 textbooks) are published in world-famous journals and presented in prestigious international scientific forums. The candidate's scientific works have 68 citations, 23 of which are from journals indexed in the first quartile of the Web of Science.

The candidate for the academic position "professor" has been a reviewer for international journals, some of which are indexed in the first quartile of the Web of Science system.

After acquiring the academic position of "Associate Professor", the candidate has been the head of seven university research projects. He also participated in the development of one other university research project.

#### **5. Scientific contributions**

As a result of the performed theoretical and experimental work by the candidate, the following results have been obtained.

- A dissipative algorithm for convex polytope refinement has been developed. This algorithm can also be applied to concave polytopes. Each concave polytope should be preliminarily partitioned into convex polytopes. It has been proved that each tesseract can be divided into cube corners of the same class, and any such cube-corner can be divided into pentatopes of the same class.

- Successive partitions of canonical four-dimensional domains have been obtained. The presented refinement strategies are optimal in regards to the measure of degeneracy and the number of congruence classes. A three-level tetra refinement tree has been obtained for all ideal domains and the red refinement strategy.

- A basic problem of the finite element method in multidimensional spaces has been solved. A conformal coupling of hypercubic and simplicial meshes has been found. All transitional elements for each Euclidean space with dimension greater than or equal to three has been determined.

- New simplicial classes related to canonical domain partitions in  $n$ -dimensional Euclidean space have been obtained and studied. It is proved that the measure of degeneracy for all considered sequences of simplices grows unboundedly when the dimension of the space tends to infinity. The rate of divergence for each of the considered sequences is calculated. Analytical relations between the studied simplicial classes have been proved. Invariant simplices have been found concerning different refinement methods.

- In the three-dimensional space, sequences of successive triangulations are considered so that each edge of each element in each level is divided into two equal parts (into three equal parts). For such sequences, the optimal refinement strategies have been found concerning the degeneracy measure for all canonical domains. The obtained methods generate only cube corners and regular simplices. The advantages of the new partition

methods are demonstrated by solving an anisotropic diffusion problem in shrinking domains and by triangulating curvilinear domains with turning lines.

- A new iterative algorithm for detecting the intersection of convex polytopes has been obtained. The new algorithm is independent of the space dimension. This algorithm can detect not only the intersection of two convex polytopes with the same dimensions but also the intersection of convex polytopes with different dimensions. The presented algorithm was tested in 12-dimensional space.

- New methods for solving nonlinear nonlocal boundary value problems have been developed.

- Finite element bases, orthogonal bases, and quadrature formulae have been developed in 4D transitional elements. An orthonormal basis is defined by Jacobi polynomials in a cubic pyramid. Quadrature formulae with an algebraic degree of accuracy up to 12 have been obtained by the least square method. For efficient construction of the formulae, the abscissa is decomposed into symmetrical orbits. The resulting quadrature formulas are symmetric, with positive weights and nodes inside the element. In order to concentrate the mass, new interpolation quadrature formulas in cubic pyramids and bipentatopes have been developed. By enriching a standard four-dimensional Lagrange finite element with 15 nodes, a new 21-point isoparametric finite element has been obtained.

- Numerical methods and algorithms for classification of voice signals have been developed. Neural networks have been constructed to solve nonlinear nonlocal boundary value problems.

## **6. Assessment of the candidate's personal contribution**

Assoc. Prof. Dr. Todor Todorov participated in the competition with 24 journal articles, 10 conference proceedings papers, and 4 textbooks. The candidate has submitted nine publications with an impact factor related to this competition. Three of the candidate's standalone articles are indexed in the first quartile of the Web of Science system, another standalone article is indexed in the fourth quartile of the Web of Science system. This proves that Assoc. Prof. Dr. Todor Todorov can formulate and lead the solution of research problems, which is confirmed by his work with Ph.D. and undergraduate students. Based on the above and my personal impressions of the candidate's work, I believe that the contributions to the works presented in the competition for "professor" are his personal work.

All minimum national requirements for holding the academic position of "professor" and the requirements of the Regulations for acquiring scientific degrees and holding academic positions at the Technical University of Gabrovo are met.

## **7. Critical remarks**

The documents are prepared according to the requirements and I do not see any significant critical remarks to the candidate and to the materials submitted for participation in the competition.

## **8. Personal impressions**

I have known the candidate for more than twenty years. From my collaboration with him, I can state that he is an established specialist in the field of computational mathematics and his works are at a high scientific level, which can be seen from the citations he has received.

## **9. Conclusion**

Assoc. Prof. Dr. Todor Todorov presents his works and personal data, which successfully defend his claims in the competition. In conclusion, the following summaries can be made:

- The candidate Assoc. Prof. Dr. Todor Todorov has presented scientific papers that are sufficient in accordance with the established requirements for the scientific title "Professor".

- He has original creative achievements at a high scientific level, sufficient in volume and significance for the award of the scientific title "Professor".

**Having in mind the above, I strongly recommend Assoc. Prof. Dr. Todor Dimitrov Todorov to be elected "Professor" in higher education area 4. Natural Sciences, Mathematics, and Informatics, professional field 4.5 Mathematics, specialty "Computational Mathematics".**

26.10.2021

Member of the scientific jury: /signature/

/Prof. D.Sc. Eng. R. Ilarionov/