

STATEMENT

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of the materials submitted for participation in a competition for the academic position of "associate professor" at Plovdiv University "Paisii Hilendarski" on:

field of higher education 4. Natural sciences, mathematics and informatics;
professional field 4.5. Mathematics;
scientific specialty Approximation models and applications

In the competition for " Associate Professor ", announced in the State Gazette, issue 96 of 17.11. 2023 and on the website of Plovdiv University "Paisii Hilendarski" (PU) for the needs of the Department of Computer Technologies at the Faculty of Mathematics and Informatics (FMI), as the only candidate participated Ph.D. Maria Tonkova Vasileva-Chilibinova, Assistant professor, from the department mentioned above.

1. Totally presented according to the procedure and the candidate

By order No. PD-21-389 of 16.02. 2024 of the Rector of Plovdiv University, "Paisii Hilendarski" was appointed as a member of the scientific jury of a competition for the academic position of "associate professor" at the PU on:

- field of higher education 4. Natural sciences, mathematics and informatics;
- professional management 4.5. Mathematics;
- scientific specialty Approximation models and applications.

At the first meeting of the scientific jury, held on 22.02. 2024 using technical means of communication (according to the Regulations of the PU), I was chosen to prepare an opinion on the said competition. The set of materials presented by the candidate for participation in the competition, Ph.D. Maria Vasileva-Chilibinova, is in accordance with the provisions of the Regulations for the Development of the Academic Staff of the University

In 2007, Maria Vasileva graduated from the secondary school "St. Kliment Ohridski" in his hometown of Silistra. In 2011, he obtained a bachelor's degree, majoring in "Informatics" at the PU. Then, in 2012, at the same university, she graduated with full honors with a master's degree, majoring in "Applied Mathematics". From 2013 to 2016, he was a full-time doctoral student at the Department of Mathematical Analysis of the FMI at the PU. The topic of her dissertation is:

"Accelerated convergence of families of iterative methods for simultaneous approximation of zeros of polynomials".

After successfully defending her thesis, she successively held the academic positions of "assistant" and "principal assistant" at FMI. The main academic disciplines taught so far by the "Associate Professor" candidate are:

- Insurance mathematics;
- Practical applications of insurance mathematics;
- Discrete math;
- Introduction to information technologies;
- Information technologies in mathematics;
- Informatics, etc.

The following is a quote belonging to the head of the Department of Computer Technologies - Prof. A. Iliev, taken from an official reference in the competition documents:

"In his teaching work Chief Assistant Professor Maria Vasileva-Chilibinova, PhD, demonstrates high professionalism and responsibility, and the courses she leads are at a high scientific, applied and methodical level..."

I have no reason to doubt the above.

It follows from the presented documents that Ph.D. M. Vasileva-Chilibinova worked on 5 research projects, of which 1 was national and 4 were university. In addition, there are 12 participations in national and international conferences and seminars. He is the supervisor of 4 graduates who have successfully defended their bachelor's and master's degrees at the PU.

For the sake of clarity, the following table presents the minimum national requirements for occupying the academic position "associate professor" and the corresponding indicators achieved by the candidate:

A group of metrics	Minimum number of points required by law	Submitted materials by the applicant	Number of points of the candidate
A Dissertation work	50	Dissertation work	50
B Habilitation work	100	Monograph: M. Vasileva, Approximation problems and applications, Plovdiv, Plovdiv University Press (2023)	100
C. Scientific publications (outside the habilitation thesis)	200	Publications: - 4 publications in journals classified in JCR quartiles as follows: Q1 – 2 pieces $\Rightarrow 2 \times 75 = 150$ points; Q2 – 2 pieces $\Rightarrow 2 \times 60 = 120$ points. - 7 publications in SJR-classified journals: SJR – 7 pieces $\Rightarrow 7 \times 30 = 210$ points. -1 monograph and 1 publication without point contribution	480
D. Citations in scientific publications	50	44 citations distributed as follows are presented: - 32 citations in journal publications that are referenced in Web of Science and Scopus $\Rightarrow 32 \times 8 = 256$ points; - 12 non-journal citations referenced in the specified databases $\Rightarrow 0$ points	256

The following table shows the minimum requirements for holding the academic position of "associate professor" in the FMI of the PU and the corresponding achievements of the candidate:

number	indicators	minimum number	presented by the candidate
1	publications	8	14
2	publications in scientific journals	5	9
3	journal publications with IF	3	4
4	teaching aids	1	1
5	citations	5	44

From the above tables, it can be seen that the candidate for associate professor satisfies all the minimum restrictions for holding this position (national and university). In addition, the works submitted for participation in the competition are not "used" for the acquisition of the scientific degree "Ph.D." and for the occupation of the academic position "Chief Assistant Professor".

The impact factor journals in which Ph.D. M. Vasileva-Chilibinova has published scientific results are as follows:

- Applied Mathematics and Computation, (IF in 2019=3,472);
- Mathematics, (IF in 2021=2,592);
- Symmetry, (IF in 2020=2,713);
- Axioms, (IF in 2022=2,000).

The total impact factor is 10.777.

I will note that four of the contestant's posts (out of a total of 14) are solo. Of these, I will highlight the publication in the IF Axioms journal, as well as the monograph mentioned above. Independent publications are rare in modern scientific research. This applies even more clearly to scientists who have not yet been habilitated. This fact impressed me and (frankly speaking) made me very happy.

The citations submitted for participation in the competition are a total of 44 (in my opinion, the exact number of citations is significantly higher). About half of the citing publications are by authors from abroad. A total of 8 publications of the candidate for the academic position "associate professor" were cited.

The non-audit work of the participant in the competition is diverse. Here I will mention her participation in several important committees, such as:

- commission for State examinations and diploma defenses of FMI;
- FMI quality commission;
- PU internal audit commission, etc.

2. General characteristics of the applicant's activity

The textbook included in the documents for participation in the competition is entitled "Insurance Mathematics" and is co-authored with prof. N. Kyurkchiev. It is intended (mainly) for the students of the PU who are studying the course of the same name. The authors' stated goal is to acquire basic knowledge and skills in simulation modeling and analysis of insurance processes. The study of risk through modern mathematical and, in particular, statistical methods has penetrated deeply into the needs and responsibilities of society. Today, it is impossible to imagine the development of public relations without such important applications of mathematics, such as: life insurance, health insurance, pension insurance, property insurance, management consulting, investments, brokerage consulting, software development, etc. The discussed textbook is dedicated to these questions. This circumstance determines its importance. The main types of distributions and the belonging of specific samples to the respective type of distribution have been studied in detail. Fundamental attention in the textbook is given to the concepts of risk and uncertainty in insurance and their connection and difference. The main risk indicators and measures such as: "value" and "value tail" are defined. The basic principles of insurance and reinsurance, calculation of insurance premiums, etc. are explained. The textbook is written relatively "popular", i.e. does not require serious prior preparation of the reader. Included (of course - where necessary), useful for self-preparation (not strictly mathematical) comments. Their presence predisposes the reader to

understanding the educational material and indicates its close connection with the practical work of insurers. Numerous examples and problems are presented to illustrate the methods discussed. Original mathematical software packages implemented in a modern mathematical environment, such as CAS Wolfram Mathematica, are substantially and repeatedly used. The quality and modern thematic content of the study aid convince me that Chief Assistant Professor M. Vasileva-Chilibinova has an affinity for teaching work and can successfully manage the teaching of some basic mathematical disciplines at the FMI of the PU.

The monograph has a single author - the participant in the competition. It is dedicated to the research of some new modern and already established models in theory and practice. The models are based on relatively recently introduced probability distributions, designed for modeling data from various fields, such as: engineering applications, medicine, insurance, finance, etc. It consists of seven chapters, which are divided into two parts. In the first part, the greatest attention is devoted to the study of the "saturation" characteristic to the horizontal asymptote in terms of the Hausdorff distance. In the second part of the monograph attention is paid to the analysis of some new classes of activation functions. The proposed topics in the monograph are demonstrated using sufficient examples with real data. Several dynamic modules implemented in the CAS Wolfram Mathematica mathematical environment are given. We will note one important feature of the modules presented by the author – they can be extended as well as adapted for other probability distributions and data sets.

An important (first) part of M. Vasileva-Chilibinova's scientific research is occupied by her works (together with prof. P. Proynov from PU), devoted to simultaneous finding of the zeros of polynomials. This mathematical theory started at the end of the 19th century through the works of K. Weierstrass in the case where the zeros of the polynomial are simple (single). The underlying recurrence formula has the form:

$$x^{k+1} = x^k - W(x^k), \quad x^k = (x_1^k, \dots, x_n^k), \quad k = 0, 1, \dots, \quad (a)$$

$$W(x^k) = (W_1(x_1^k), \dots, W_n(x_n^k)), \quad W_i(x^k) = f(x_i^k) \left(a_0 \prod_{j \neq i} (x_i^k - x_j^k) \right)^{-1}, \quad i = 1, \dots, n,$$

where n is the degree of the polynomial f and a_0 is its senior coefficient. Subsequently, various clarifications, improvements, modifications, summaries, etc. were found. of the above recurrence formula (a). We can proudly state that Bulgarian mathematicians have contributed significantly to the development of this theory. Here we will mention the Bulgarian scientists: B. Sendov, P. Burnev, K. Dochev, V. Popov, A. Andreev, N. Kyurkchiev, P. Proynov, S. Ivanov, S. Cholakov and others. Of course, we must also include the contestant here. One of the most serious studies and summaries of methods for simultaneous approximation of simple zeros of polynomials belongs to L. Ehrlich (1967):

$$x^{k+1} = x^k - E(x^k), \quad k = 0, 1, \dots, \quad (b)$$

$$E(x^k) = (E_1(x_1^k), \dots, E_n(x_n^k)), \quad E_i(x^k) = W_i(x^k) \left(1 + \sum_{j \neq i} \frac{W_j(x^k)}{x_i^k - x_j^k} \right)^{-1}, \quad i = 1, \dots, n,$$

We will note that the finding of the form of the operator by the operator W presented above in (b) is due to W. Börsch-Supan. Another generalization belongs to M. Farmer, G. Loizou (1977) and I. Gargantini (1978) and concerns the simultaneous approximation of multiple zeros of polynomials. It is assumed that the multiplicities of

the zeros are known in advance. In the case of simple zeros, the last method coincides with the method of L. Ehrlich. A few years later, N. Kyurkchiev, A. Andreev and V. Popov introduced and studied an infinite series of iterative methods for simultaneous approximation of zeros of polynomials (with known multiples). The first member of this series is the method of M. Farmer, G. Loizou and I. Gargantini. In the discussed studies, included in the current competition, new theorems for local convergence of the considered family of iteration methods have been proved. In particular, the results of the aforementioned Bulgarian mathematicians are summarized.

Modifications of L. Ehrlich's method have been investigated in which L. Ehrlich's formula is combined with other iterative functions. Here it is convenient to use the following notation of the iterative method family:

$$T_i(x^k) = \begin{cases} x_i^k - \left(\frac{f'(x_i^k)}{f(x_i^k)} - \sum_{i \neq j} \frac{1}{x_i^k - \Phi(x_i^k)} \right)^{-1}, & \text{if } f(x_i^k) \neq 0; \\ x_i^k, & \text{if } f(x_i^k) = 0, \end{cases} \quad , \quad i = 1, \dots, n. \quad (c)$$

In the above iteration procedure Φ is the iteration function that defines the type of combination of correction methods. These methods the authors call L. Ehrlich methods with correction. The local and semi-local convergence of these types of methods is studied. In semilocal convergence, the constraints that the initial conditions satisfy can be checked by computer programs. The studies are validated with appropriate numerical examples.

L. Ehrlich's method with a combination of Newton's method, also known as A. Nourein's method, is discussed in detail (we will recall that the method is designed to simultaneously find all simple zeros of polynomials of arbitrary degree with the fourth order of convergence). Here the function Φ (see (c)) is the Newton iteration function. More precisely, a generalization of the method described above, which applies to finding all zeros of polynomials (not only the prime ones), which have a previously known multiplicity, was studied in the submitted works for the competition. As in previous works of the authors, attention is concentrated in proving local and semi-local convergence of these iteration methods

The second thematic direction in the research of Ph.D. M. Vasileva-Chilibinova is related to the approximation of cumulative functions by step functions. An important element in this approach is the choice of the metric accounting for the "closeness" of features. Here I will definitely, with conviction and with special praise, point out that the choice of the Hausdorff metric is extremely appropriate. In my humble opinion, this metric is convenient and productive when comparing partially discontinuous functions (to which class step functions belong) or functions that "abruptly" change the "direction" or "magnitude" of their monotonicity. In the presented works (as well as in the monograph) the important characteristic "saturation" in the Hausdorff sense is investigated. Useful estimates for the value of the Hausdorff distance have been proven. A number of classes of probabilistic cumulative functions and their approximation by O. Heaviside's function are considered.

In general, the scientific results of the participant in the competition for 'Associate Professor' consist of completing and summarizing scientific knowledge on certain topics. The contributions consist in the formulation and proof of these (more precisely, theorems) important for the scientific fields (object of the above discussions in the opinion). Research has a "mixed" theoretical and applied nature. Most of the results

are provoked by the need and the possibility of mathematical modeling of real processes.

I do not have a document (protocol, agreement, etc.) that establishes, classifies or distributes the degree of participation of each of the co-authors in the creation of the general publications that are presented in this competition. Therefore, I consider that the candidate's participation in obtaining the presented overall results is equivalent to the other co-authors.

3. Critical remarks and recommendations

I have no critical notes. The time I spent getting acquainted (albeit briefly) with the work of the participant in the "Associate Professor" competition was useful and pleasant for me. Although I do not know Ph.D. Maria Vasileva-Chilibinova personally, I am fully confident that her career development will continue "upward" (or "forward" - I don't know exactly where the positive direction is). Therefore, it is unnecessary to recommend it (it will come true even without my kind wishes).

CONCLUSION

The comments and analyzes made above in the opinion give me reason to draw the following conclusions:

1. The textbook presented for participation in the competition is useful for students. It reflects the modern trends in education in the relevant applied mathematics disciplines;

2. Scientific works contain new theoretical studies. The obtained results develop and enrich mathematical knowledge. They are an original contribution of the candidate for acquiring the scientific title "Associate Professor";

3. The obtained results are closely related to some areas of mathematical modeling - the scientific specialty for which the discussed contest was announced;

4. The research has been published in renowned journals that are reflected in the Web of Science and Scopus databases, and some of them have an impact factor;

5. Ph.D. M. Vasileva-Chilibinova was the supervisor of several graduates who successfully defended their diplomas;

6. Through the established multiple citations (without self-citations noticed by me), I conclude that the research is of scientific interest to scientists in the relevant scientific field at home and abroad;

7. The peer-reviewed materials have not been used so far for the candidate's academic growth;

8. The candidate's achievements meet (and in some indicators repeatedly exceed) the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB) and the Regulations for the Implementation of the LDASRB regarding the occupation of the academic position "Associate Professor";

9. The presented educational and scientific materials satisfy the specific minimum requirements of the FMI of the PU;

10. I have not detected plagiarism.

Summary: I consider it justified to give my **positive** assessment and to recommend the Scientific Jury to prepare a report-proposal to the FMI Faculty Council for the election of the Chief Assistant Professor Maria Tonkova Vasileva-Chilibinova, Ph.D.,

to the academic position of "Associate Professor" at the PU "Paisii Hilendarski" by:
field of higher education 4. Natural sciences, mathematics and informatics;
professional direction 4.5. Mathematics; scientific specialty Approximation models and
applications.

30.03. 2024

Prepared the opinion:

(Prof. Angel Dishliev)