

STATEMENT REPORT

under the procedure for acquisition of the educational and scientific degree “Doctor”

by candidate **Mira Lachezarova Spasova**

of the PhD Thesis entitled:

“Analytical methods for solving some classes of fuzzy integro-differential equations”

In the Scientific field: **4. Natural Sciences, Mathematics and Informatics**

Professional field: **4.5. Mathematics,**

Doctoral program: “**Mathematical analysis**”,

Department: “**Mathematical analysis**”,

Faculty of Mathematics and Informatics (FMI),

University of Plovdiv “Paisii Hilendarski” (PU),

The review is prepared by: Prof. Boyan Georgiev Zlatanov, Dr.Sci - University of Plovdiv “Paisiy Hilendarski”, Faculty of Mathematics and Informatics, Department of Mathematical Analysis, in my capacity as a member of the scientific jury, according to Order No. RD-21-454/23.02.2024 of the Rector of PU and the decision of the first meeting of the jury, I was chosen to present a Statement Report.

1. General characteristics of the dissertation thesis and the presented materials

According to the Rules for the Development of the Academic Staff of the PU, the dissertation candidate has submitted the complete set of documents.

The PhD thesis is based on 4 publications, indexed in WoS and SCOPUS with $SJR > 0$, and one in ACM Digital Library. The PhD student has successfully passed the required exams for the training to acquire the educational and scientific degree “doctor”.

This quick review shows that **Mira Spasova** satisfies the formal minimum national requirements for obtaining a PhD degree in the Scientific field of higher education: 4. Natural sciences, mathematics and informatics; professional field: 4.5. Mathematics and has successfully completed his studies at FMI at PU.

The PhD thesis, submitted for defense, is 108 pages long, consists of introduction, four chapters, the first of which is and preliminary one in the field of fuzzy sets and fuzzy integrals, a conclusion chapter and bibliography of 103 items.

The methods used by the author can generally be systematized as a theory of fuzzy sets, decomposition method fuzzy integro-differential equations, fuzzy analytical methods and fuzzy transforms, finding of approximate solution with the help of sequences of successive iterations.

2. Short CV and personal impressions of the candidate

The PhD student was born in 1995 in Bulgaria. She graduated consecutively with bachelor's and master's degrees at PU in 2018 and 2019, respectively. From 2020, she continues her studies as a PhD student at PU.

I have formed my impressions of the PhD student from presentations and talks she gave and from personal, informal contacts in FMI at PU. I can say that Mira Spasova is interested in research in the field of the doctoral program. She is able to present the obtained results in understandable language.

3. Content analysis of the scientific and applied achievements of the candidate, contained in the presented PhD thesis and the publications to it, included in the procedure

In the introduction, the author has made an overview of the subject. Attention is paid to integro-differential equations that arise naturally in physics. One direction of research in this field is the construction of models in which there is no certain information, which leads to the concept of fuzzy set and the fuzzy integro-differential equations generated by it. The set of goals and techniques for their achievement are formulated. The introduction ends with a structure of the thesis.

In Chapter 1, the author presented the main concepts and results.

A good impression is made by the presence of numerous figures and examples in the text.

Chapters 2, 3 and 4 are devoted to the new results obtained by the author.

Necessary and sufficient conditions for the existence and uniqueness of the solution of nonlinear fuzzy integro-differential equations of Volterra-Fredholm have been found. Obtaining this result requires that contractive conditions are issued, which makes it possible to prove the convergence of the series of successive iterations and to find estimates of the error. Fuzzy analytical methods for finding approximate solutions of nonlinear Volterra-Fredholm integro-differential equation and exact solutions of linear partial fuzzy Volterra integro-differential equation are constructed. Fuzzy transforms are defined to find the exact solutions of a linear or linear partial fuzzy Volterra integro-differential equation. Properties of the introduced concepts were investigated.

The author's contributions are correctly described in the dissertation.

4. Approbation of the results

- a) The PhD thesis work is based on 5 publications from conferences.
- b) The doctoral student has submitted a thesis that satisfies the group of indicators "A" with 50 points.

- c) The total number of points with which the candidate participates in the group of indicators "D" in the procedure for acquiring the educational and scientific degree "doctor" is 138 points. Therefore, it follows that Mira Spasova satisfies the minimum national requirements.
- d) **there is no plagiarism proven in the legally established order in the submitted dissertation work and scientific papers under this procedure in the sense of the “Law on the Development of the Academic Staff in the Republic of Bulgaria” in the Republic of Bulgaria.**

Qualities of the abstract

The presented abstracts in Bulgarian and in English meet the requirements of the PU and correctly systematize the results of the presented thesis.

5. Critical notes and recommendations

Despite exceeding the national requirements by several times, I believe that basing a PhD thesis only on publications from AIP Conference Proceedings and one from an ACM Digital Library conference is not a good practice. I also believe that it would be good for the PhD student to have at least one independent publication that does not need to be in indexed editions.

6. Conclusion

Having become acquainted with the PhD thesis presented in the procedure and the accompanying scientific papers and on the basis of the analysis of their importance and the scientific and applied contributions contained therein, **I confirm** that the presented PhD thesis and the scientific publications to it, as well as the quality and originality of the results and achievements presented in them, meet the requirements of the “Act on Development of the Academic Staff in the Republic of Bulgaria”, the Rules for its Implementation and the corresponding Rules at the University of Plovdiv “Paisii Hilendarski” (FMI-PU) for acquisition by the candidate of educational and scientific degree “Doctor” in the Scientific field 4. Natural Sciences, Mathematics and Informatics, Professional field 4.5. Mathematics. In particular, the candidate meets the minimal national requirements in the professional field and no plagiarism has been detected in the scientific papers submitted for the competition.

Based on the above, I give a **positive assessment** and **recommend** to the scientific jury to award **Mira Lachezarova Spasova**, the educational and scientific degree “Doctor” in the Scientific field 4. Natural Sciences, Mathematics and Informatics, Professional field 4.5. Mathematics, Doctoral program: “Mathematical analysis ”.

April 5, 2024

Reviewer:

/Boyan Zlatanov, Professor, Dr.Sci. /