



## REVIEW

**on the dissertation thesis of Stela Dimitrova Todorova  
titled “Research on index matrices and their applications”  
submitted for acquiring of the educational and scientific degree “Doctor”  
in professional track 5.3. Communication and Computer Techniques  
scientific specialty Computer Systems and Technologies**

1. Stela Todorova was born on February 3, 1989 in Burgas, Bulgaria. In 2014 she completed a master program “Information Security” at the Burgas Free University. Since October 2020 she has been a regular PhD student at the university “Prof. Dr. Assen Zlatarov” – Burgas.

2. The dissertation thesis of Stela Todorova spans over 112 pages and consists of an Introduction, 5 chapters, Conclusion, Contributions, a list of 5 publications related to the theme of the dissertation thesis, declaration of originality of the results and a Bibliography containing 213 titles.

The dissertation thesis is devoted to theoretical research and applications of the apparatus of the index matrices – a mathematical object which I defined some 40 years ago.

Without going into much details about the content of the thesis, I will mention the most significant contributions and mistakes in it.

The first chapter is a review but contains some elements of originality. It contains the basic definitions of the theory of the index matrices, following the content of my monography by Springer from 2014, as well as some more recent publications authored by me and other researchers. It is important to note that in the chapter for the first time a short review on the publications on index matrices is given. This review follows a paper of the candidate published in the *Annual of “Informatics” Section of the Union of Scientists in Bulgaria* ([3] in the list “*Publication on the dissertation thesis*”).

To me, the most interesting chapter is Chapter 2 because it contains new results from the theory of the index matrices. Up to now, problems related to solving equations with index matrices have not been studied. In comparison to the titles of the papers on which the first chapter and its two subchapters are based, there is an inaccuracy here – it is correct to say “Solving of equation with index matrices...”, i.e. without the word “matrix” before “equations”. Despite this terminological inaccuracy as well as the presence of a series of print errors, the results are original and represent a new direction of development

of the theory of the index matrices. A wide collection of equations with index matrices is studied which contains various operation over these matrices. The cases when the specific equation has minimal solution are pointed out. I hope that the PhD candidate will not stop working at this point because I see a possibility for research of other types of equations with index matrices.

The other group of results in Chapter 2 is related to the research on the properties of the determinants and permanents of index matrices something which has not been done up to now. The chapter ends with examples for the application of the apparatus of the index matrices to the representation of the block diagrams and elements of the analytical geometry in the plane.

In Chapter 3, a representation of a logic scheme through index matrix is described while in Chapter 4 – a representation of digital signals and stochastic processes through index matrices. I am not an expert in these areas and I cannot estimate the value of the obtained results, but as far as I am trying to follow the publications on index matrices I can say with certainty that I have no knowledge of similar studies up to now. I can evaluate as interesting the result related to a random process and Markov's chain. Obviously, this is a first step in this direction but according to me this study is worth of further development in future.

The last chapter – Chapter 5 – contains a description of a program realization of index matrices and operations over them in Excel. Such program product had not been developed previously and I hope that it will be useful for the specialists working with index matrices.

As I pointed out above, there are some inaccuracies in the text – both terminological and linguistics (for instance, on page 4 the term “permanent” is written incorrectly) but they do not change the good impression from the original ideas.

3. The author's summary of the dissertation (in both Bulgarian and English) reflects the content of the dissertation thesis and meets to the requirements of the ZRAS and the Regulations for the Conditions and Order of Acquiring of Scientific Degrees and Holding Academic Positions at the University “Prof. Dr. Assen Zlatarov” – Burgas.

4. From the applied reference it can be seen that Stela Todorova is author of 5 publications related to the dissertation thesis one of which is in a specialized series of Springer with SJR, one in the Korean Journal *Proceedings of the Jangjeon Mathematical Society (SJR)* and three papers in other journals published in Bulgaria. As one of the editors of the journal *Annual of “Informatics” Section of the Union of Scientists in Bulgaria*, I can confirm that the main results from Chapter 5, in the form of a paper, are in press and are expected to appear in Vol. 13, 2024. It is not clear to me why the paper [5] is included in the list with publications on the thesis since it has no relation to the thesis.

The first 4 papers, however, are related to the dissertation thesis and based on them the candidate meets the requirements of the Regulations for the Conditions and Order of Acquiring of Scientific Degrees and Holding Academic Positions at the University “Prof. Dr. Assen Zlatarov” – Burgas.

I have no information about citations of papers of Stela Todorova but as I pointed out above the first two papers contain new results related to the theory of the index matrices and probably will be cited in near future.

Taking into account the above said, I give a positive evaluation of the dissertation thesis and the presented materials and I recommend to the honorable members of the Scientific Jury to vote for awarding the educational and scientific degree **Doctor in professional track 5.3. Communication and Computer Techniques, scientific specialty Computer Systems and Technologies to Stela Dimitrova Todorova.**

21 August 2024

Reviewer: .....  
(Acad. Prof. DSc DSc Krassimir Todorov Atanasov,  
Dept. “Bioinformatics and mathematical modeling”,  
IBPhBME- BAS)

Подписе заличен  
Чл.2 от ЗЗЛД