



REVIEW

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About: Dissertation thesis for the award of
educational and scientific degree "Doctor"
in the area of higher education 5. Technical Sciences,
professional track 5.3. Communication and Computer Techniques,
PhD program Computer Systems and Technologies

Author of the dissertation thesis: Stela Dimitrova Todorova

Title of the dissertation thesis: Research of the index matrices and their applications

Supervisors: Assoc. Prof. Veselina Kuncheva Bureva,
Assoc. Prof. Nora Angelova Angelova

1. **Justification and general description of the presented materials**

By order № UD-257/16.07.2024 г. of the Rector of University "Prof. Dr. Assen Zlatarov" – Burgas I am appointed to prepare a review as a member of the scientific jury (appointed by order № UD-236/03.07.2024) in the procedure for defence of a dissertation thesis titled Research of the index matrices and their applications for acquiring of the educational and scientific degree Doctor in area of higher education 5. Technical Sciences, professional track 5.3. Communication and Computer Techniques, PhD program Computer Systems and Technologies. Author of the dissertation thesis is Stela Dimitrova Todorova.

The materials presented by Stela Dimitrova Todorova for the procedure: dissertation thesis, author's summary of the dissertation thesis, copies of 5 publications related to the dissertation and a reference for fulfillment of the minimal requirements for acquiring of the educational and scientific degree Doctor are prepared according to the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation 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.

2. Actuality of the topic and research methodology

Objects of research in the dissertation thesis are index matrices and more specifically – theoretical research and applications of the apparatus of the index matrices – a mathematical object defined 40 years ago. Index matrices have many applications in the representation of big data structures, graph theory, generalized nets, etc. The large number of publications during the past few years on some aspects of the theory of the index matrices, as well as on various applications of the apparatus of the index matrices justifies the actuality of the topic of the dissertation thesis.

As a result of the research, a solution of equations with index matrices the elements of which are real numbers and intuitionistic fuzzy pairs is obtained; the properties of determinants and permanents are studied; functionally constructive modules are represented through index matrices; index matrices are applied to the study on random processes.

3. Knowledge about the problem

The dissertation thesis and the presented publications show that Stela Dimitrova Todorova has a good knowledge on the subject. Her knowledge about the problem is clearly evident from the writing style, the performed analysis and drawn conclusions, the comprehensive and up-to-date bibliography consisting of 213 sources. With very few exceptions, the sources in the bibliography are described correctly and comprehensively and are cited in the corresponding places in the text. It is evident that the author has a broad knowledge in the field of mathematics and uses well various terms from areas such as algebra, analytical geometry, mathematical logic, etc.

4. Evaluation of the dissertation thesis

The dissertation thesis presented by Stela Dimitrova Todorova is written well. It spans over 113 pages and contains 32 figures and 1 table. It is structured according to the widely accepted norms, namely: Introduction, Chapter 1: Introduction to the theory of the index matrices; Chapter 2: New results in the theory of the index matrices; Chapter 3: Representation of a logical scheme through index matrices; Chapter 4: Research through the use of index matrices on binary signals and random processes; Chapter 5: Representation of index matrices through tables in Excel; Conclusion; Contributions in the dissertation thesis; Statement for originality of the results and Bibliography.

In the Introduction, the author has presented a good motivation for the choice of the topic, its actuality, as well as the main goal of the dissertation thesis and the formulated tasks the fulfillment of which leads to reaching the goal.

In Chapter 1, the basic notions of the theory of the index matrices are presented shortly, following a well-known monography published in 2014 and devoted to the index matrices. A brief review of the publications on the theory and applications of the index matrices is made.

In Chapter 2, new results in the theory of the index matrices are presented. For the first time, problems related to solving equations with index matrices are studied. Here, a lack of consistency in the use of some terms is present. For instance, in this chapter the author incorrectly uses on several occasions the expression “solving matrix equations with index matrices”. The correct expression is “solving of equations with index matrices”. Equations with index matrices are studied and the cases when a given equation has a minimal solution are pointed out. The properties of the determinants and permanents of index matrices are studied as well. Examples are given for the application of the apparatus of the index matrices to the representation of block diagrams and some elements of the analytical geometry. The results presented in this chapter are a good base for further research on the theory of the index matrices.

In Chapter 3, a representation of a logical scheme with the help of index matrices is presented. Functionally constructive modules are presented through index matrices. Through the aggregation of the index matrix of the distances, the minimum value, the maximum value and the sum of the distances of the conductors connecting the assembly places can be found.

In Chapter 4, digital signals and random processes are represented through index matrices. A program is created which using 6 receivers of an Arduino controller, configured as exits, assigns 6 logical values. An index matrix of a random process is described. The changes of the state of a Robocar managed with Arduino controller with index matrix of the transitions are analyzed.

In Chapter 5, a program realization of index matrices and the operations over them is described in Excel. The product can be useful for all using index matrices.

In the Conclusion, an overview of the results included in the first three chapters of the dissertation thesis is made. Some conclusions are drawn.

5. Contributions

I accept all contributions formulated by Stela Dimitrova Todorova. As a result of the research, important results with scientific and applied scientific character are obtained. The method for solving of equations with index matrices and the study of the properties of determinants and permanents of index matrices are significant scientific contributions of the dissertation thesis. Among the applied scientific and purely applied results, it is worth mentioning the representation through index matrices of block diagrams of functionally constructive modules, construction of maps of knowledge, etc.

I confirm that I have not found any evidence of plagiarism in the dissertation thesis.

6. Publications on the topic of the dissertation thesis

Stela Dimitrova Todorova has presented copies of 5 papers which contain the main results of the dissertation thesis. Among them, the paper [5] can not be considered a publication related to the thesis. The remaining 4 publications are all related to the dissertation thesis and with them the author meets the minimal requirements specified in the Regulations for the Conditions and Order of Acquiring of Scientific Degrees and Holding Academic Positions at the University “Prof. Dr. Assen Zlatarov” – Burgas.

7. Author’s dissertation summary

The author’s dissertation summary spans over 45 pages. It is prepared according to the requirements of the Act on Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation 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. Its content reflects exactly and fully the content and the results of the dissertation thesis.

8. Conclusion

Taking into account the above said, I consider that the dissertation thesis has sufficient scientific and applied scientific contributions and meets the requirements of the the Act on Development of the Academic Staff in the Republic of Bulgaria, the Regulations for its implementation 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. Therefore, I give a **positive evaluation** of the dissertation thesis, the author’s summary of the dissertation thesis, the scientific publications and contributions of Stela Dimitrova Todorova.

On the grounds of the achieved scientific, applied scientific and applied results I **recommend** to the honourable scientific jury to award the educational and scientific degree Doctor in area of higher education 5. Technical Sciences, professional track 5.3. Communication and Computer Techniques, PhD program Computer Systems and Technologies to Stela Dimitrova Todorova.

9 September 2024

Reviewer: ..

Подпис заличен
Чл.2 от ЗЗЛД

/Assoc. Prof. Velin Andonov, PhD/