

OPINION

under the procedure for obtaining the educational and scientific degree “Doctor”

by

Tedis Arben Ramaj

of the Dissertation Thesis entitled: “Algebraic methods for studying some combinatorial configurations and their applications”,

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

Professional field: 4.5. Mathematics

Doctoral program “Algebra, topology and applications”, Department of Algebra,

Faculty of Mathematics and Informatics (FMI), Sofia University “St. Kliment Ohridski” (SU)

The statement report has been prepared by **prof. Dr. Sci. Tsonka Stefanova Baicheva**, in the capacity as a member of the scientific jury for the defense of this dissertation according to Order № ПД-38-129 / 01.03.2021 of the Rector of the Sofia University.

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

The dissertation is 86 pages long and contains an introduction and three chapters. The introduction provides a brief overview of the emergence and development of research on orthogonal arrays, indicates their practical applications and the main tasks to be solved. The first chapter contains definitions and main results for orthogonal arrays, their connections with the error correcting codes are clarified and special attention is paid to the orthogonal polynomials, which are the main tools of the research in the dissertation. The main goal of the dissertation is formulated - the study of the structure of q -ary orthogonal arrays as well as the two main problems that are solved by this study. The concept of distance distribution of orthogonal arrays and codes has been introduced. The results obtained in the dissertation are presented in the second and third chapters.

The bibliography contains 45 titles, 4 of which are works by the author of the dissertation. Both classical developments and the latest results obtained in recent decades by Bulgarian and foreign scientists are included.

2. Short CV and personal impressions of the candidate

Tedis Ramaj obtained a Master's degree in Mathematics from the University of Tirana in 2013. Since then, she has worked as an assistant professor at Elbasan University, Tirana University and Tirana Polytechnic University, where she is giving lectures and seminars on Algebra, Geometry, Mathematical analysis, Applied mathematics.

I do not know Tedis Ramaj and I have no personal impressions of her.

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

In the dissertation the properties of orthogonal polynomials together with additional combinatorial techniques are used to determine the possible distances in a ternary orthogonal

array, the nonexistence of ternary orthogonal arrays with fixed parameters is proved and upper bounds for the covering radius of an orthogonal array are derived.

The concept of orthogonal arrays were introduced in the 1940s in connection with a specific practical task related to increasing the efficiency of experiments planning. They later found applications in computer science and cryptography. Due to their various practical applications, rich combinatorial structure and connection with the finite fields, geometry and error correcting codes, orthogonal arrays are subject of numerous scientific studies where techniques from different fields of mathematics are used. There still are many open questions related to the existence, classification and calculation of basic parameters of orthogonal arrays, which determines the relevance of the topic of the dissertation.

Polynomial and combinatorial techniques are used in the dissertation for determination of the distribution of possible distances in an orthogonal array with fixed parameters. The problem is reduced to solving linear systems with positive integer coefficients. An algorithm for finding the possible distances has been developed, which is based on a result obtained in a recent work by Nikolay Manev.

In the Corollary 2.4.1 and Theorem 2.4.2 some properties of the possible distances of an orthogonal array are proved, and on their basis conclusions are drawn about its structure. An example of OA $(18,7,3,2)$ is considered, which illustrates the application of this approach.

In the last section of the second chapter of the dissertation the non-existence of OA $(108,16,3,3)$ and OA $(108,17,3,3)$ is proved by calculating the possible minimum distances for the two orthogonal arrays and then showing that they do not satisfy the conditions of Theorem 2.4.2. With this approach, results are also obtained for the structure of OA $(108,15,3,3)$ and OA $(1458,16,3,5)$, which can be useful in the construction of orthogonal arrays with the correspondig parameters.

In the third chapter, two analytical upper bound for the covering radius of an orthogonal array are obtained, which depend on their basic parameters. It is also shown that when the basic parameters of the orthogonal array satisfy certain conditions, the upper bound for the covering radius is reduced by one.

4. Approbation of the results

The dissertation is written on the basis of three papers, one of which is in a journal with impact factor. The obtained results are also presented in six conference papers. All publications on the dissertation are co-authored with the supervisors, and one is with another co-author. I accept the contribution of the candidate in these publications as equal.

No citations of the doctoral dissertations are given.

The three articles are included in the reference for compliance with the minimum national requirements under Art. 26 of the Law on the Acquisition of Scientific Degrees "Doctor" and carry 72 points out of the required 30.

The scientific papers on which the dissertation is written

a) meet the minimum national requirements (under Art. 2b, para. 2 and 3 of ZRASRB) and respectively the additional requirements of Sofia University "St. Kliment Ohridski" for obtaining the educational and scientific degree "Doctor" in the scientific field "Natural Sciences, Mathematics and Informatics", professional field 4.5 Mathematics;

b) the results presented by the candidate in the dissertation and in the scientific works to it do not repeat those from previous procedures for acquiring a scientific title and academic position;

c) there is no legally proven plagiarism in the submitted dissertation and scientific papers under this procedure.

5. Qualities of the abstract

The abstract gives a clear and adequate idea of the content and main results of the dissertation.

6. Critical notes and recommendations

The candidate had to put more efforts and diligence in shaping the text of the dissertation and to eliminate a significant amount of spelling and stylistic errors. Not only do they make it difficult to read, but in some places they also cause a problem with understanding the meaning of the text.

7. Conclusion

Having become acquainted with the dissertation 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 dissertation presented 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 ADAS in the Republic of Bulgaria, the Rules for its Implementation and the corresponding Rules at the Sofia University "St. Kliment Ohridski" (FMI-SU) for acquisition by the candidate of the educational and scientific degree "Doctor" in the Scientific field 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 recommend** to the scientific jury to award Tedis Ramaj the educational and scientific degree „Doctor” in the Scientific field Natural Sciences, Mathematics and Informatics, Professional field 4.5. Mathematics.

Date: 19.04.2021

Signature:

/prof. Dr. Sci. Tsonka Baicheva/