OPINION
under the procedure for acquisition of Doctor of Science degree
from Prof. Dr. Alexandra Andreeva Soskova,
topic of the dissertation: COMPUTABLE STRUCTURE THEORY: JUMP OF STRUCTURE, CODING AND DECODING
in professional field 4.5 Mathematics (Mathematical Logic),
Department of Mathematical Logic and its applications,
Faculty of Mathematics and Informatics (FMI),
Sofia University St. Kliment Ohridski (Sofia University),

By Prof. Dr. Tinko Velichkov Tinchev,
Sofia University St. Kliment Ohridski, Faculty of Mathematics and Informatics, professional field 4.5 Mathematics (Mathematical Logic) in his capacity of Member of the Scientific Jury for awarding the scientific degree "Doctor of Science" following Order# RD 38-613/ 21.12.2020 of the Rector of Sofia University St. Kliment Ohridski

1. General characteristics of the dissertation and the presented materials

The presented dissertation in English is 270 pages, including the title pages and the content. It is structured in eight chapters. The first chapter is an introduction, the second contains preliminary concepts and results, the chapters 3 to 7 contain the main part of the study, and Chapter 8 is a bibliography of 162 titles. All documents required by the law and its regulations are presented. Two detailed reviews from prominent specialists in the field are also presented - Sergey Goncharov (SL Sobolev Institute of Mathematics, SB RAS) and Antonio Montalban (The University of California, Berkeley).

2. Information about the Candidate

Alexandra Soskova graduated in 1979 with a Master's Degree in Mathematical Logic from the Faculty of Mathematics and Mechanics of Sofia University "St. Kliment Ohridski ". In 1990 she defended her PhD thesis in mathematical logic under the scientific guidance of Prof. D.Sc. Dimitar Skordev in the field of computational theory, in which she has worked ever since.

From 1979 to 1981 she was a mathematician at the Science and Technology Institute, from 1981 to 1986 she was a researcher at SYSTEMISOT, from 1990 to 1991 she was a researcher at the Scientific Research Center of Sofia University "St. Kliment Ohridski". From

1993 to 2005 she was consecutively an assistant, senior assistant and chief assistant at the Department of Mathematical Logic and its Applications at Faculty of Mathematics and Informatics (FMI). From 2005 until 2019, she has been an Associate Professor in the same department. From 2019 she is a full Professor at FMI. In two consecutive terms, 2008-2016, she was the head of the department. I would like to particularly acknowledge her care and successful efforts in the development of the staff and in attracting young assistants to the department as well as the academic spirit in the department under her leadership.

In the period 2015-2016, Prof. Alexandra Soskova is the Deputy Dean of FMI. She actively participated in the life of the academic community - for two terms (1999-2017) she was a member of the Academic Council of the University from the quota of non-habilitated professors, from 1999 until now (except 2006-2008) is a member of the Faculty Board of the FMI. She has been a member of various committees (academic, elective, Erasmus coordinator, etc.) at the FMI and the General Assembly of Sofia University.

In addition to regular university administrative activities, Prof. Alexandra Soskova actively serves the international professional community as chairwoman and member of a number of organizational and program committees at international scientific conferences. Since 2010, she has been a member and chairwoman of various association bodies for the Association for Symbolic Logic.

3. Analysis of the scientific and scientific-applied achievements of the candidate, contained in the presented dissertation and the publications on it, included in the procedure

The dissertation is a systematic introduction to modern effective model theory - an important part of mathematical logic - and reflects the research of A. Soskova in the field over the past at least 15 years.

The second chapter of the dissertation introduces the basic concepts, methods and facts necessary for further exposition - Turing reducibility, Turing jump, generic sets, forcing method, enumeration reducibility and two approaches to characterization of the complexity of a structure - through the degree spectrum of structure and through definable relations.

The third chapter is devoted to the concept of jump of a structure. The approach to this concept is original and is based on relative search computability of Moschovakis. The approaches of other authors are analyzed and two jump inversion theorems on structures are proven.

The fourth chapter is devoted to finding model-theoretic conditions sufficient for the so-called strong jump inversion. The task is interesting due to the fact that there are a number of studied classical structures with respect to strong jump inversion. The conditions found, although not applicable to all known cases in which there is a strong jump inversion, are general

enough to imply a Marker and Miller's result and to be applied in a number of other cases. As a consequence, it is proved that the saturated model of differentially closed fields with characteristic 0 has a computable copy.

Chapter five is devoted to effective coding and decoding of classical classes of structures. For example, graphs are shown that are not Medvedev reducible to the jump of any linear order, but each graph is Medvedev reducible to the second jump of a linear order. A Mal'tsev result from 1960 shows that each field has a copy, which is defined in the corresponding Heisenberg group by existential formulas with parameters. Two proofs of the existence of such formulas without parameters are given. The second one provides sufficient conditions for elimination of parameters from syntactic interpretations.

The sixth chapter is devoted to an effective variant of the classical ultraproduct of structures - the cohesive product introduced by R. Dimitrov, in which the role of the ultrafilter is simulated by a cohesive set. It turns out that taking different computable copies of the standard natural numbers, very different order types of cohesive powers can be obtained.

Chapter seven examines some natural substructures of the structure of enumeration degrees. The skip inversion theorem is proven. The chapter, as well as the dissertation, ends with several unsolved problems and hypotheses related to the skip operation.

As can be seen from the above brief review of the results in the dissertation, they are hot topics in the effective model theory. Most of them are from the last 5-6 years and are characterized by depth and originality

4. Approbation of the results

The dissertation is based on 10 publications by Alexandra Soskova, 1 of which is authored only by A. Soskova, 3 of which are co-authored with I. Soskov, and the remaining 6 are co-authored with a significant number of co-authors. I accept the author's statement about the equality of contributions. Two of these articles are in the Journal of Symbolic Logic (one is published and the other has an acceptance document), two are published in the Journal of Logic and Computation, one is published in Transactions of the American Mathematical Society, two of the articles are published in the Lecture Notes in Computer Science series and two of the articles in the Proceedings of the Panhellenic Logic Symposium (6th and 7th). One of the articles is presented for publication. As can be seen, 5 of the publications are in the most reputable specialized journals referenced in WoS, and 2 of them (in LNCS) are referenced in Scopus. The citations of these articles are 29 with IF or SJR and 9 in monographs (WOS). The minimum scientometric indicators required by law have been met. Alexandra Soskova's scientific results are well known to the international logical community - since 2006 she has given over 25 lectures at seminars at a number of foreign universities in the USA, Europe, Asia, Australia and South America, and is also a regular participant in close specialized scientific conferences and workshops Computability in Europe and Logic Colloquium. This is a certain guarantee of no plagiarism.

5. Qualities of the extended abstract of the dissertation

The presented extended abstract of the dissertation correctly reflects the content of the dissertation, the contributions of Alexandra Soskova and the current trends in computable structure theory. I find it too long - 120 pages in English and 121 pages in Bulgarian, with an additional 13 pages of bibliography. The reason probably rests in the intention to make it accessible to a relatively wide audiance of mathematicians and to describe in detail the emergence of specific issues. I find that the text in Bulgarian and the text in English match each other.

6. Critical remarks and recommendations

I find the presentation to be well-balanced and accessible, not only for PhD students with a narrow specialization in the field of computational theory, but also for good students enrolled in the Master's programs in Logic and Algorithms. I recommend that the dissertation be published as a monograph.

7. Conclusion

After getting acquainted with the dissertation presented in the procedure and the accompanying scientific papers and based on the analysis of their significance and the scientific and applied contributions contained in them, I confirm that the presented dissertation and scientific publications to it, as well as the quality and originality of the results and achievements presented in them, **meet the requirements** of ZRASRB, the Regulations for its application and the respective Regulations of Sofia University St. Kliment Ohridski for acquiring from a candidate the scientific degree Doctor of Sciences in the scientific field of Natural Sciences, Mathematics and Informatics and professional field 4.5 Mathematics.

The candidate meets the minimum national requirements in the professional field and no plagiarism has been established in the scientific papers submitted for the procedure.

Based on the above, I **recommend** the scientific jury **to award to Prof. Dr. Alexandra Andreeva Soskova degree "Doctor of Science"** in the field of Natural Sciences, Mathematics and Informatics, professional field 4.5 Mathematics (Mathematical Logic).

March 20, 2021

The opinion is prepared by:

Prof. Dr. Tinko Velichkov Tinchev