

REFEREE STATEMENT

on the procedure for obtaining the educational and scientific degree "Doctor"

by

candidate: **Srebrin Toshkov Kolev**

dissertation topic: **A time-dependent formulation of the HEXNEM3 nodal method for solving the neutron transport equation in diffusion approximation**

in the professional field: **4.1 Physical sciences,**

doctoral program: **Neutron Physics and Nuclear Reactor Physics,**

Faculty of Physics, Sofia University "St. Kl. Ohridski"

The referee statement was prepared by **Assoc. Prof. Dr. Venelin Kozhuharov**, Faculty of Physics, Sofia University "St. Kl. Ohridski", as a member of the scientific jury in the professional field: 4.1 Physical Sciences, doctoral program: Neutron Physics and Nuclear Reactor Physics according to Order **№ RD-38-235 / 24.06.2020** of the Rector of the Sofia University "St. Kl. Ohridski".

1. General characteristics of the dissertation and the presented materials

The candidate has presented a dissertation of 155 pages, including an introductory part; three chapters, describing the main research work and serving as the core part of the dissertation; conclusion; literature. The manuscript also contains an addendum. The introductory part presents the main tasks of the dissertation and offers in addition an overview of the approaches applicable to the numerical modeling of neutron transport. 59 references on the topic are cited. The achievements in the dissertation are further supported by 36 figures and 37 tables. The main mathematical expressions serving as the base for the numerical modeling of the neutron transport are derived in the addendum.

2. Data and personal impressions of the candidate

Srebrin Kolev was born in 1992. In 2015 he graduated with a bachelor's degree in Nuclear Engineering and Nuclear Energetics from Sofia University, and in 2017 he obtained a master's degree "engineer-physicist in nuclear energetics and technology" again at Faculty of Physics, Sofia University. Since November, 2017 he has been holding the position of "technical assistant" at the Department of Nuclear Engineering and Nuclear Energetics at the Faculty of Physics, Sofia University, where he still works as of today. I've personally known the candidate since he has

joined the NTNE department, where he conscientiously and timely has been fulfilling his obligations for the maintenance of the students education laboratory. Srebrin Kolev is critical to himself, which helps him to properly assess the obtained scientific results. The candidate also works successfully with students from the bachelor's program "NTNE".

3. Analysis of the scientific achievements of the candidate presented in the dissertation and the publications

The scientific topic of the dissertation is highly relevant for the physics of nuclear reactors and for the detailed understanding and modeling of the processes occurring inside them. The candidate has focused on the numerical solution of the neutron transfer equation and the key achievements of the presented work are the developed methods and algorithms for finding a numerical solution of the time-dependent two-group diffusion problem for VVER type reactors, used in currently operating nuclear power plants. These methods make it possible to follow the change of the parameters of the reactors in the short period after their start-up until the nominal power is reached - critical for their reliable operation. The presence of many operating VVER type reactors confirms the relevance of the chosen topic.

The specific problem solved by the candidate is the development of a new time-dependent formulation of the HEXNEM3 method, which allows non-iterative solution of the two-group diffusion problem. A key point is the chosen modal decomposition of the scalar flux, which reduces the considered problem to a system of independent inhomogeneous Helmholtz equations.

A software product H3CM has been implemented. It has been studied for accuracy, stability and efficiency of the obtained solutions by considering a series of mathematical test-problems and comparing the obtained results against fine-cellular reference solutions of the two-group diffusion problem. In this sense, the research described in the candidate's dissertation can be summarized as development of new methods for solving already known problems and their verification. Validation, namely comparison of the obtained numerical solutions with experimental data, has not been part of the undertaken work.

4. Approbation of the results

The results presented in the dissertation are published in 3 publications - two in journals with impact factor / impact rank, one of which is in the first (Q1) and the other in the second (Q2) quartile. The third publication is without impact factor, but is indexed in international databases. According to the adopted score system, these publications provide a total of 55 points, which is more than the required 30 points for awarding a PhD degree. In all presented publications Srebrin Kolev is the first author and they are only co-authored with the research advisor of the candidate - Assoc. Prof. Dr. Ivaylo Hristoskov. This allows me to consider the contribution of Srebrin Kolev in the aforementioned publications as leading. The candidate has also participated in two international scientific conferences, where he is the first author in the presented talks.

The publication activity of the candidate also exceeds the additional requirements of the Faculty of Physics, Sofia University "St. Kliment Ohridski" to the

candidates for acquiring a PhD degree in professional field 4.1. Physical sciences. So far, no independent citations of the candidate's publications have been noticed.

The results presented by the candidate in the dissertation and the attached scientific papers are original and do not repeat those of previous procedures for obtaining scientific degrees or applications for academic positions. In addition, the nature of the results and the papers used in the dissertation, as well as their publication in peer-reviewed and indexed journals, entirely excludes plagiarism.

5. Qualities of the extended abstract

The extended abstract of the PhD thesis contains 40 pages (in English) and practically follows the main achievements of the candidate's work. The identified scientific contributions are stated clearly and correctly reflect the accomplished work.

6. Critical remarks and recommendations

The materials presented by the candidate for the acquisition of PhD degree are of an extremely high level. The scientific language shows a deep understanding of the issues and expertise in the field of neutron physics and nuclear reactor physics. The ease of use of the terminology by the candidate, however, has led at some places in the text to difficult-to-understand paragraphs, which require extra effort in reading them. When listing the materials which serve as the basis of the dissertation, the publications are not separated from the participation in international conferences. In some places in the extended abstract there are references to parts of the dissertation without actually including them in the extended abstract (e.g. to table III.7, which is only in the dissertation, etc.), which prevents this manuscript to be treated independently as self-consistent scientific work.

Those remarks, however, are technical and in no way decrease the scientific value of the dissertation and the work of the candidate.

7. Conclusion

After critically reviewing the dissertation presented in the procedure and the accompanying scientific papers, and based on the analysis of their significance and the scientific and applied achievements inside them, I **confirm** that the submitted dissertation and scientific publications attached to it, as well as the quality and originality of the results and achievements presented within them, fulfil the requirements of ZRASRB, the Regulations for its application and the additional Regulations of Sofia University "St. Kliment Ohridski" for awarding a PhD degree to the candidate in the professional field **4.1 Physical science** and doctoral programme **Neutron physics and nuclear reactor physics**. In addition, the dissertation itself and the extended abstract impress with the extremely high style of the candidate's scientific expression and demonstrate the expertise acquired by him in the field.

Based on the above, I **strongly recommend** the scientific jury to award Srebrin Toshkov Kolev a PhD degree in scientific field **4.1 Physical Science (Neutron Physics and Nuclear Reactor Physics)**.

06.09. 2020.

Prepared by: 

(Assoc. Prof. Dr. Venelin Kozhuharov, FzF,

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