Opinion

by Assoc. Prof. D.Sc. Pavlin P. Groudev, Head of the Laboratory "Nuclear Energy and Nuclear Safety" at the INRNE-BAS, member of the scientific jury for the defence of the dissertation

of M.Sc. Srebrin Kolev for acquiring the scientific and educational degree "Doctor", according to the Order of the Rector of Sofia University "St. Kliment Ohridski" No. RD 38-235/24.06.2020

Topic of the Ph.D. Thesis (Dissertation): "A time-dependent formulation of the HEXNEM3 nodal method for solving the neutron transport equation in diffusion approximation".

Doctoral program: Neutron physics and physics of nuclear reactors. Field of higher education: 4. Natural sciences, mathematics and informatics. Area 4.1: Physical sciences.

This opinion was prepared on the basis of the dissertation, abstract (in Bulgarian and English), a list of the doctoral student's publications, a reference for compliance with the national minimum requirements and the additional requirements in the FzF of Sofia University and the author's CV.

The dissertation is organized in a total of 155 pages, in four chapters, of which 3 are basic and one as appendices, including 36 figures and 37 tables. The dissertation contains seven additional sections, of which 4 at the beginning and 3 at the end of the dissertation, which represent an introduction, overview, conclusions, literature and bibliography. The numbering in the dissertation and the abstract is generally observed, but there are small differences.

1. Relevance of the problem developed in the dissertation in scientific and scientific-applied terms.

The presented dissertation is relevant and important for reactor physics and nuclear safety. The studied problems are related to improvements in the nodal methods for solving the neutron transport equation in two-group diffusion approximation in order to model the neutron-physical behaviour of WWER-type nuclear reactors. The diffusion problem is solved for a triangular lattice of hexagonal fuel assemblies, and the scalar neutron flux is decomposed into basis functions within each homogenized node. The obtained results allow improvement of existing methods for solving the neutron transport equation.

2. Degree of knowledge of the state of the problem and creative interpretation of the literary material.

The knowledge of the researched problems is seen from the formulation of the goals and the way of their solution. Excellent knowledge of the subject allows the correct application of the selected methods to achieve the goals that the author sets in the dissertation. The review of the researched problem shows that the author of the dissertation has got acquainted with and uses the experience of leading institutions worldwide, working in the field of reactor physics. Moreover, he proposes in his dissertation a new approach to the implementation of the HEXNEM methods. Using the technique of modal decomposition, the doctoral student successfully applies it to solve diffusion problems.

3. Correspondence of the chosen research methodology and the set goal and tasks of the dissertation with the achieved contributions.

The dissertation presents the new non-stationary formulation of the HEXNEM3 method developed by the doctoral student, which allows joint non-iterative solution of the two-group diffusion problem. This is achieved by pre-applying modal decomposition of the scalar fluxes. An additional innovation compared to the original HEXNEM3 method is the creation of a new ACMFD scheme for it, which linearly connects the boundary net neutron current with the average scalar fluxes for two adjacent nodes. The developed coded implementation is called H3CM.

In order to obtain reference solutions for H3CM verification, a hybrid scheme, i.e. fine-mesh finite-difference in the transverse plane and nodal along the vertical axis, for solving the two-group diffusion problem was created and described in detail in the dissertation. The accuracy of the method and the quality of the coded implementation H3CM are checked through solving several test problems. For each test problem and calculated state, the power distribution by nodes is normalized to unit average value.

4. Scientific and/or scientific-applied contributions of the dissertation.

The presented scientific-applied contributions of the dissertation are formulated as conclusions in the dissertation and as contributions in the abstract.

The defined three scientific-applied contributions are generally correct and correctly reflect both the actual work done by the author and his personal contribution, both in the modelling and in solving the test problems and the presented analyses.

I generally accept the thus defined scientific and scientific-applied contributions of the dissertation.

6. Opinions, recommendations and notes.

I have several recommendations and remarks that arose after reading the dissertation:

- There is no definition/formulation of ACMFD in Bulgarian - analytical coarse-mesh finite-difference.
- There is no clear definition of the goal, which is understood rather from the presentation of the results.
- The use of certain colloquial expressions and words (jargons) may not be the most appropriate in terms of adherence to a scientific and technical format, and to some extent clarity is lost.
- The use in several places of extremely long sentences - there is for example a sentence that is on 7 lines, including in the conclusions, is not appropriate.
- Some important quantities for the dissertation, as e.g. reactivity, as well as their measurement units, are not explained.

7. Conclusion with a clear positive or negative assessment of the dissertation.

The presented Ph.D. dissertation and the extended abstract are generally well formed and cover all requirements for obtaining an educational and scientific degree "DOCTOR". Reading the dissertation shows the excellent preparation of the doctoral student in modelling the physical processes he studies. His analytical thinking and search for different approaches to solving extremely important problems related to reactor physics and nuclear safety stand out clearly.

The recommendations and remarks presented by me I would like to be considered as wishes in his future works and do not reduce in any way the positive assessment that is formed in me.

Based on the presented results, as well as from my participation in the preliminary appraisal of the dissertation of M.Sc. Srebrin Kolev, I have reason to give a positive assessment of the dissertation and to recommend to the esteemed scientific jury to award him the educational and scientific degree "DOCTOR".

15.08.2020

JURY MEMBER: .....

/ Assoc. Prof. P. Groudev, D. Sc. /