Federal State Autonomous Educational Institution of Higher Education

«NATIONAL RESEARCH TOMSK POLYTECHNIC UNIVERSITY»

AGREED
Director of School of
Nuclear Science & Engineering

_____ Oleg Y. Dolmatov
«24» 10 2022

APPROVED
Vice-Rector for Academic Affairs

_____ Mikhail A. Solovyov
«25» 10 2022

Head of Research and Training Centre for
International Nuclear Education and Career,
School of Nuclear Science & Engineering

_____ Vera V. Verkhoturova
«21» 10 2022

Entrance Test Programme for
Master Degree Programme "Nuclear Science and Technology"
field of training 14.04.02 Nuclear Science and technology

Director of Master Degree Programme "Nuclear Science and Technology" _____ (signature) Vera V.Verkhoturova

DEVELOPED:

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Tomsk 2022

SUMMARY

Field of training: 14.04.02 Nuclear Science and Technology
Master Degree Programme: Nuclear Science and Technology

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Entrance Test (ET) programme for the Master Degree Programme "Nuclear Science and Technology" is developed on the basis of Federal State Standard of Higher Education (undergraduate level in the field of training "Nuclear Science and Technology").

The aim of the ET is to determine abilities of applicants to master basic professional educational programmes of higher education at the master's level, as well to select candidates who are most capable and well prepared to master the programme "Nuclear Science and Technology' which is implemented in English language.

GENERAL REQUIREMENTS FOR ENTRANCE TEST PROCEDURE

ET for the Master Degree Programme "Nuclear Science and Technology" in the field of training 14.04.02 "Nuclear Science and Technology" is conducted in English language in the form of oral interview and solving practical tasks.

ET is performed by the examination board in English language with each applicant individually. The oral interview involves applicant's answers to theoretical questions, which allows assessing the level of development of general professional competencies provided for by the Federal State Standard for Higher Education (undergraduate level in the field of training "Nuclear Science and Technology"). Each candidate is interviewed for about 45 minutes. The oral interview with each applicant includes 3 questions – one randomly selected question referred to the sections of the ET programme (see "Contents of sections and topics of the Entrance test programme"). At the end of the oral interview, the applicant is to solve one practical task related to one of the sections of the ET programme (see "Contents of sections and topics of the Entrance test programme").

On the day of the ET, applicants are admitted to the examination room in accordance with the list following which each applicant is assigned with the time set for the interview.

Examination board members are entitled to ask 1-2 additional questions referred to the topics of the sections of ET programme. Candidates' answers to theoretical questions in the oral interview and results of practical tasks solutions are fixed in ET protocol, which is developed immediately after the completion of EE procedure, and communicated to and acknowledged by each of the candidates.

Candidate, who takes issue with the grade received upon completion of ET and (or) breach of ET procedure, has a right to file an appeal. Procedure for appeal filing and hearing is subject to Regulations on Appeals Board (approved by TPU Rector on May 22, 2014).

CONTENTS OF SECTIONS AND TOPICS OF THE ENTRANCE TEST PROGRAMME

Section	Topic
1. Features of physical phenomena in the microworld	– The main stages of nuclear physics and nuclear power engineering development – Types of fundamental interactions – Scales and units of measurement of the microworld
2. Static properties of atomic nuclei	– Mass and nucleus binding energy – The size of atomic nuclei – Spin and magnetic moments of nuclei – Nuclear forces – Mechanism of nucleons interaction
3. Nuclear models	– Classification of nuclear models – The Fermi gas model – Liquid drop nuclear model – Shell model – Unified model
4. Radioactivity and activity	– Radioactivity – Activity – Laws of radioactive decay – Radioactive series
5. Alpha-decay	– The condition of alpha decay – Cluster decay – Theory of alpha decays
6. Beta-decay	– Types of beta decays and conditions of their occurrence – Theory of beta decay
7. Gamma radiation	– Gamma radiation – Nuclear isomerism – Other ways of de-excitation of a nucleus
8. Nuclear fission and fusion	– Elementary theory of fission and nuclear synthesis – Chain process and nuclear reactor
9. Interaction of radiation with matter	– General laws of radiation interaction with matter – Interaction of light charged particles with matter – Interaction of heavy charged particles with matter – Interaction of gamma radiation with matter – Interaction of neutron radiation with matter
10. Nuclear reactions	– Classification of nuclear reactions with matter – Types of nuclear reactions and reaction energy – Effective cross sections of interaction – Reaction energy scheme and reaction threshold energy

RECOMMENDATIONS FOR ENTRANCE TEST PREPARATION

Main readings:

1. Basic Ideas and Concepts in Nuclear Physics. An Introductory Approach / K. Heyde. — Third Edition. - Bristol: Institute of Physics Publishing, 2004. — 638 p.

2. Introduction to Nuclear Reactions / C. A. Bertulani, P. Danielewicz, Bristol: Institute of Physics Publishing, 2004, 515 p.

3. Nuclear and Particle Physics / B. R. Martin, Chichester: John Wiley & Sons, Inc., 2006, 411 p.

4. Nuclear and Particle Physics / B. Milner Edinbourg: Cambridge University Press, 2005, 92 p.

Additional readings:

1. An Introduction to Nuclear Physics / W. N. Cottingham, D. A. Greenwood, 2nd., Edinburg: Cambridge University Press, 2001, 271 p.

2. Basic Ideas and Concepts in Nuclear Physics. An Introductory Approach / K. Heyde, Third Edition, Bristol: Institute of Physics Publishing, 2004, 638 p.

3. Introductory Nuclear Physics / Krane Kenneth S.: John Wiley & Sons, Inc., 1988, 864p.

Internet resources:

1. MIT open courseware. Nuclear science and engineering course available at: https://ocw.mit.edu/courses/nuclear-engineering/

2. MIT open courseware. Applied nuclear physics course available at: https://ocw.mit.edu/courses/nuclear-engineering/22-101-applied-nuclear-physics-fall-2006/

3. MIT open courseware Introduction to applied nuclear physics available at: https://ocw.mit.edu/courses/nuclear-engineering/22-02-introduction-to-applied-nuclear-physics-spring-2012/index.htm

4. MIT open courseware. Neutron science ad reactor physics course available at: https://ocw.mit.edu/courses/nuclear-engineering/22-05-neutron-science-and-reactor-physics-fall-2009/index.htm

5. MIT open courseware. Introduction to nuclear and particle physics course available at: https://ocw.mit.edu/courses/physics/8-701-introduction-to-nuclear-and-particle-physics-spring-2004/

ASSESSMENT CRITERIA

Maximum score obtained by a candidate for the ET performance is 100 points. Minimum score, which shall be obtained by a candidate to be successfully admitted to the Master Degree Programme, is 56 points. Final score for ET is defined as the total number of points gained by a candidate for answers to theoretical questions and solutions to practical tasks.

Answer to a theoretical questions and practical task solution are assessed by the Examination board on the basis of the following criteria:

Points	Criteria
0-7	Answer does not contain essential information. Candidate demonstrates inability to apply knowledge in practice.
8-14	Partially correct or insufficiently complete answer / solution to a task indicates significant gaps in the theoretical and practical training of a candidate. Answer is superficial and signals misunderstanding of the topic.
15-20	Candidate demonstrates sufficiently full understanding of the subject, good knowledge, skills and practical experience; the required learning outcomes are developed. A sufficiently complete answer is given, which is accompanied by independent judgments. There are minor flaws in the presented solution of a practical task.
21-25	Cognitive, deep and complete answer (theoretical and practical) is demonstrated which indicates excellent understanding of the subject, comprehensive knowledge, ability to substantiate the answer and prove one's own judgments by practical solution of a task and development of formulae.