

Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Educational Institution of Higher Education
“Peter the Great St. Petersburg Polytechnic University”
INSTITUTE OF ENERGY

APPROVED

Director IE

V.V. Barskov

« 18 » 2024.

ENTRANCE EXAM PROGRAM
for those enrolling in the first year
for main educational programs of the major
14.04.01 «NUCLEAR POWER ENGINEERING AND THERMAL PHYSICS»

programs:

- Nuclear Power Engineering (international education program)

Saint-Petersburg
2024

ANNOTATION

This document lists the professional cycle topics (questions) from the Bachelor's degree curriculum in 14.04.01 «NUCLEAR POWER ENGINEERING AND THERMAL PHYSICS» MAJOR, used in the Master's program entrance exam.

The entrance examination is scored out of 100 points; a minimum score of 50 (50%) is required to pass. Exams for English-taught programs will be conducted in English.

Educational program manager



Ya.A. Vladimirov

The program is considered and recommended for publication by the Academic Council of the Institute (Minutes No. 10 of "15" November 2024).

1. DISCIPLINES INCLUDED IN THE MASTER'S ENTRANCE EXAMS PROGRAMME

1. Nuclear physics and theory of neutron transfer
2. Thermodynamics and heat-and-mass transfer
3. Fluid and gas mechanics
4. Language proficiency

2. CONTENT OF ACADEMIC DISCIPLINES

1. Nuclear physics and theory of neutron transport

1. Structure of atomic nuclei
2. Radioactivity
3. Nuclear reactions
4. Nuclear interactions and macroscopic cross-sections of interaction
5. Mechanisms of interaction with neutrons
6. Full macroscopic cross-section
7. Doppler effect
8. Neutron diffusion, Fick's law
9. Diffusion equation
10. Neutron deceleration
11. The age equation

References

1. Fundamentals of theory and calculation methods for nuclear power reactors [Text]: Textbook. manual for universities / Ed. G.A. Batya. - M.: Energoizdat, 1982. -- 511 p.
2. Feinberg, S.M. The theory of nuclear reactors [Text]: textbook. for universities / S.M. Feinberg, S.B. Shikhov, V.B. Trojan. - M.: Atomizdat, 1978. -- 400 p.
3. Lamarsh, J.R., Introduction to Nuclear Reactor Theory. New York: Addison-Wesley Publishing Company, 2002.

2. Thermodynamics and heat-and-mass transfer

1. Laws of thermodynamics. Thermodynamic processes and cycles;
2. Real gases. Water vapor. Wet air;
3. Thermodynamics of flows;
4. Thermodynamic analysis of cycle efficiency;
5. Phase transitions;
6. Thermodynamic cycles of steam turbine and gas turbine plants. Cycles of combined cycle plants;
7. Theory of heat transfer: thermal conductivity, convection, radiation;
8. Calculation of heat transfer processes;
9. Refrigeration and cryogenic equipment;
10. Intensification of heat transfer;
11. Fuel and combustion basics;
12. Application of heat in the industry;

13. Secondary energy resources

References

1. Kirillin V.A. Technical Thermodynamics / Kirillin V.A. Sychev V.V. Sheindlin A.E. M.: Energoatomizdat, 1983. - — 416 c.
2. Isachenko V.P. Heat Transfer / V.P. Isachenko, V.A. Osipova, A.S. Sukomel Publishing House. 4-th transfer and addition. - Moscow: "Energoizdat", 1981. - 415 c.
3. Holyst, R., Poniewierski A., Thermodynamics for Chemists, Physicists and Engineers. New York: Springer, 2012;
4. Incropera, Frank P. et al. Fundamentals of heat and mass transfer. John Wiley & Sons, Inc., 2007.

3. Fluid and gas mechanics

1. Models of a liquid medium; Newtonian and rheological fluids;
2. Hydrostatics: Euler's equations, the basic formula of hydrostatics, pressure on the walls; relative peace of the environment;
3. Forces acting in a fluid, normal and tangential stresses, stress tensor; equation of motion in stresses; general laws and equations of fluid dynamics: integral form of conservation laws, generalized Newton's hypothesis, Navier-Stokes equation, boundary and initial conditions;
4. Modes of flow; the concept of the boundary layer; ideal fluid model; Bernoulli's equation; similarity of hydrodynamic processes and dimensional analysis;
5. One-dimensional flow model; loss of pressure, flow in pipes, outflow of liquid and gas through holes and nozzles, gas-dynamic functions of flow; supersonic movement of gases;
6. Equation of one-dimensional unsteady motion.

References

1. L.G. Loitsyanskiy Mechanics of liquid and gas - 7th ed. - Moscow: Drofa, 2003. - — 840 c
2. Shvydkiy V.S. Fluid and Gas Mechanics / Shvydkiy V.S., Yaroshenko Yu.G., Gordon Ya.M., Shavrin V.S., Noskov A.S. 2nd ed. and additional Moscow: Akademkniga IKC Publishing House, 2003. - 464 c.
3. Durst, F., An Introduction to the Theory of Fluid Flows. Springer, 2008.

4. Language proficiency

Ability to produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.

References

1. <https://www.ielts-writing.info/EXAM/>
2. Complete IELTS. Bands 6-7, Brook-Hart Guy

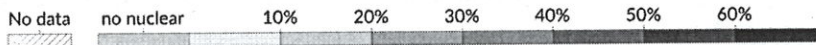
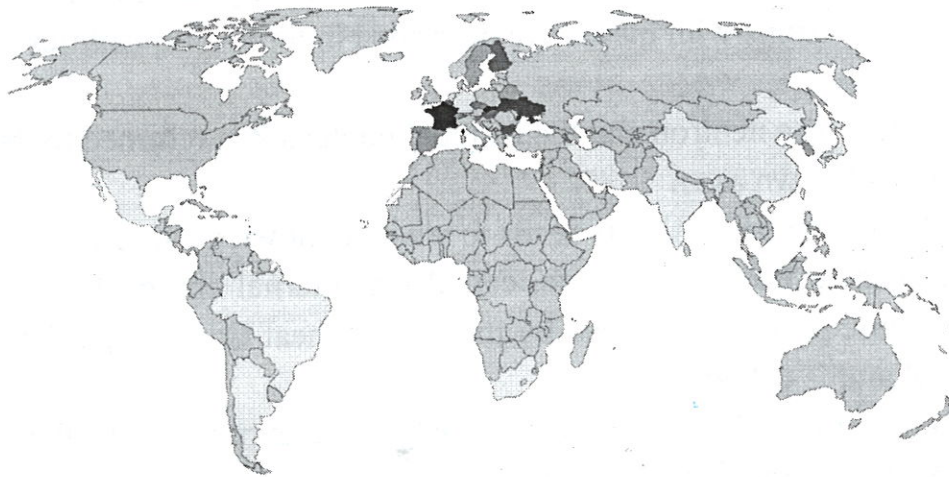
3. 3. SAMPLE QUESTIONS

4. The total number of *nucleons* in the nucleus is ...
5. The decrease in the number of undecayed nuclei in time dt is given by ...
6. The interactions of neutrons with matter are described in terms of quantities known as ...
7. If the emitted nucleon is a neutron and the residual nucleus Z is returned to its ground state the process is known as ...
8. The use of Fick's law in reactor theory leads to what is known as the ...
9. There exists an extensive function of state, called the internal energy U , whose change in a thermodynamic process is caused by the flow of heat Q , work performed W , and flow of matter Z and is called ...
10. The cycle which contains Isothermal expansion, Adiabatic expansion, Isothermal compression and Adiabatic compression is called ...
11. ... is the transfer of energy from the more energetic to the less energetic particles of a substance due to interactions between the particles.
12. ... is when the flow is caused by external means, such as by a fan, a pump, or atmospheric winds.
13. ... is energy emitted by matter that is at a nonzero temperature.
14. The volume of the atoms and/or molecules is extremely small compared with the distances between them, so that the molecules can be regarded as material points is refers to ...
15. When the temperature in a system is not constant spatially, this system is thermally not homogeneous and heat will be transferred from areas of ... temperature to areas of ... temperature.
16. The of a Newtonian fluid depends indirectly on the molecular interactions and can therefore be regarded as a thermodynamic property that varies with temperature and pressure.
17. The marked "fluid thread" which is carried with the flow and thus marks the course of the flow is called ...
18. The relation of acceleration forces and molecular momentum transport is called
19. Data Analysis: Describe the provided data graph in approximately 150 words. Highlight key features, trends, and comparisons.

Share of electricity production from nuclear, 2023

Measured as a percentage of total electricity.

Our World
in Data



Data source: Ember (2024); Energy Institute - Statistical Review of World Energy (2024)

OurWorldinData.org/energy | CC BY

20. Critical Essay: Write a short opinion essay on a current issue within the field of Nuclear Power engineering “**The role of nuclear energy in achieving net-zero emissions targets.**” Clearly state your position and support it with reasoned arguments.

4. FINAL PROVISIONS

After the interdisciplinary exam, the applicant is informed about the results of the interdisciplinary exam.

If the applicant does not agree with the result of the entrance exam, the applicant may appeal the results of the entrance exam.