

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» 8 2024.

ENTRANCE EXAM PROGRAM
for those enrolling in the first year
for main educational programs of the major
13.04.01 «HEAT POWER ENGINEERING»

programs:

- Power Plant Engineering (international education program)

Saint-Petersburg
2024

ANNOTATION

This document lists the professional cycle topics (questions) from the Bachelor's degree curriculum in Heat Power Engineering (13.04.01), 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. Thermodynamics and heat-and-mass transfer;
2. Thermotechnical measurements;
3. Fluid mechanics.

2. CONTENT OF ACADEMIC DISCIPLINES

1. Thermodynamics and heat-and-mass transfer

1. The laws of thermodynamics. Thermodynamic processes and cycles;
2. Real gas. Moisture vapor. Moist air;
3. Flow thermodynamics;
4. Thermodynamic analysis of cycle efficiency;
5. Phase transitions;
6. Thermodynamic cycles of steam and gas turbines. Cycles of combined cycle gas turbines;
7. Heat exchange theory: thermal conductivity, convection, radiation;
8. Heat exchange processes calculation;
9. Refrigerating and cryogenic engineering;
10. Heat-transfer enhancement;
11. Fuel and the fundamentals of combustion theory;
12. Heat application in the industry;
13. Secondary energy resources.

References

1. Kirillin V.A. Engineering Thermodynamics / Kirillin V.A. Sychev V.V. Sheindlin A.E. M.: Energoatomizdat press, 1983. — 416 p.
2. Isachenko, V.P. Heat Transfer / V.P. Isachenko, V.A. Osipova, A.S. Sukomel. 7th ed., corrected and expanded. - M: "Energoizdat", 1981. - 415 p.

2. Thermotechnical measurements

1. Basic concepts of metrology;
2. Standardisation and certification of measuring instrument;
3. Measurement uncertainty;
4. Methods and instruments for temperature measurement;
5. Measuring pressure, rarefaction and differential pressures;
6. Measuring flow velocity;
7. Measuring the flow rate of liquids, gas, steam and heat;
8. Analysis methods for gases and solutions;
9. Measuring transmitters and telemetering systems.

References

1. Heat-engineering measurements and instruments / Preobrazhensky V.P – M.: Energia, 1978.
2. Experimental research methods. Deficiencies and measurement uncertainties / Pokhodun A.I., Study Manual. SPb: SPbGU ITMO, 2006.

3. Fluid mechanics

1. Fluid model; Newtonian and rheological liquid;
2. Hydrostatics: Euler equations, main hydrostatic formula, wall pressure; environment relative dormancy;
3. Liquid forces, normal and internal stress, stress tensor; equation of motion; general laws and equations of fluid dynamics: integral form of conservation equation, generalized Newton's hypothesis, Navier-Stokes equation, boundary and initial conditions;
4. Flow regimes; concept of the viscous layer; ideal fluid model; Bernoulli equation; similarity of hydrodynamic processes and dimensional analysis;
5. One-dimensional flow model; pressure loss, pipe flow, fluid and gas outflow through the bores and nozzles, gas-dynamic functions of flow rate; supersonic gas flow;
6. Equation of one-dimensional transient motion.

References

1. Fluid Mechanics / Loitsyansky L.G. – 7th ed. — M.: Drofa, 2003. — 840 p
2. Fluid Mechanics / Shvydkiy V.S., Yaroshenko Y.G., Gordon Y.M., Shavrin V.S., Noskov A.S. – 7th ed., corrected and expanded — M.: ICC "Akademkniga" press, 2003. - 464 p.

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

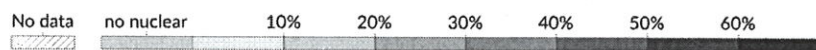
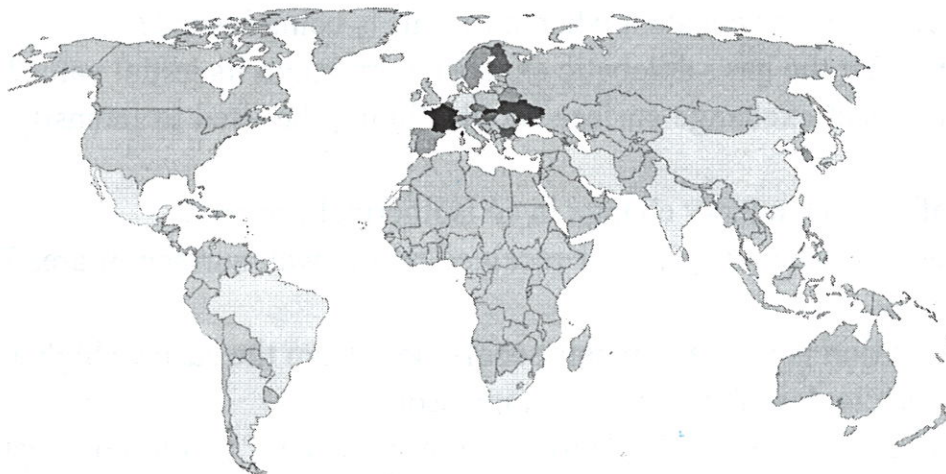
3. EXAMPLES OF TEST QUESTIONS

1. For which process is the $P_1/P_2=T_1/T_2$ ratio fair?
2. Which state parameter remains constant when moist air is being heated?
3. Can the temperature after the gas's adiabatic expansion maintain its initial value?
4. On which side of the heat exchange surface should finning be used to intensify the heat transfer?
5. What is the equal of internal energy change in an isothermal process?
6. What is the amount of heat that is given or received by the wall surface of area F in a time $t = 1\text{ s}$?
7. In which boiling condition is the heat transfer coefficient from the surface higher?
8. Which refrigeration cycle doesn't include a compressor?
9. Why does the Brighton Cycle GTU supply a large air excess to the combustion chamber when the amount of oxygen supplied is not involved in the combustion process?
10. What is measurement of uncertainty?
11. Which instrument is used to measure relative humidity?
12. What is the name of the deviation of a measured value from its true (actual) value?
13. What is the name of the set of operations conducted to confirm that measuring instruments meet metrological requirements?
14. Can the Bernoulli equation be used for granular medium?
15. What is a water hammer?
16. What is the range of Mach number values for a supersonic flow?
17. What mechanisms can transfer heat from particle to particle?
18. Under what condition can a pipe be considered hydraulically smooth?
19. Which similarity criterion links mass and inertia forces?
20. What does the sound speed in the adiabatic process depend on?
21. 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

22. Critical Essay: Write a short opinion essay on a current issue within the field of Nuclear Power engineering **“The role of artificial intelligence and machine learning in optimizing power plant operation and maintenance.”** Clearly state your position and support it with reasoned arguments.

4. FINAL PROVISIONS

The applicant is informed of the results of the interdisciplinary examination upon completion of the interdisciplinary examination.

In case of disagreement with the result of the entrance test, the entrant has the right to file an objection to the results of the entrance test.