Name of the entrance exam

Electrical engineering

Field/fields of study

13.04.02 Electrical engineering

Educational program/programs

13.04.02_21 Electrical Engineering (International Educational Program)

Abstract

The program contains a list of topics (questions) in the disciplines of the basic part of the professional cycle of the bachelor's degree curriculum in the field of 13.04.02 Electrical engineering, included in the content of tickets (test tasks) for the entrance examinations to the magistracy.
The entrance test is evaluated on a one-hundred-point scale and consists of an interdisciplinary exam in the scope of the requirements imposed by the state educational standards of higher education for the bachelor's degree level in the field corresponding to the master's degree, conducted in person in writing or remotely (the maximum score is 100). The minimum number of points confirming its successful completion is set by the Admission Rules approved for the current academic year.
The duration of the test is 90 minutes.
It is allowed to use writing materials, a draft, and a calculator during the entrance test.

Disciplines included in the program of entrance examinations for the Master's degree program

1. Theoretical foundations of electrical engineering
2. Electric machines
3. Electrical and electronic devices
4. Electrotechnical materials
5. Electrical systems and grids
6. High voltage technologies
7. Power stations

Content of academic disciplines

1. Theoretical foundations of electrical engineering
Physical foundations of electrical engineering; electromagnetic field equations.
Electrical circuit laws; sinusoidal current circuits; three-phase circuits; circuit calculation for periodic non-sinusoidal effects.
Quadripoles (two-port network); transient processes in linear circuits; nonlinear electrical and magnetic circuits; circuits with distributed parameters.
Electromagnetic field theory; electrostatic field; stationary electric field; magnetic field; analytical and numerical methods of calculating electric and magnetic fields; alternating electromagnetic field; surface effect and proximity effect; electromagnetic shielding.

References
1. Demirchan K.S., Neumann L.R., Korovkin N.V., Chechurin V.L. Theoretical Basics of Electrical Engineering, 1, 2, 3 - St. Petersburg: Piter, 2009.
2. Korovkin N.V., Selina E.E., Chechurin V.L. Theoretical Basics of Electrical Engineering: A Taskbook - St. Petersburg: Piter, 2004.

2. Electric machines
Fundamental physical laws and principles of energy conversion in electric machines. Types of electric machines and their classification; principles of operation, design, basic equations and characteristics of transformers, AC and DC electric machines.
Loss and efficiency of electric machines. Ways to startup and regulate the frequency of rotation of different types of electric motors, the basic principles and tasks of designing electric machines. Choice of their electromagnetic and thermal loads.

References
1. Electric Machines. Introduction to the Electromechanics. DC Machines and Transformers: / Voldek A.I., Popov V.V - St. Petersburg: Piter, 2008.
2. Voldek A.I., Popov V.V. Electric Machines. AC Machines: A Textbook for Universities. - St. Petersburg: Piter, 2008. https://www.elec.ru/files/2020/01/17/voldek-ai-popov-vv-elektricheskie-mashiny-mashiny.PDF

3. Electrical and electronic devices
Classification of electrical and electronic devices. Dynamic characteristics of electromagnetic mechanisms.
Nominal current, nominal shutdown current, thermal and electrodynamic withstand current of high-voltage circuit breakers. Electrodynamic forces in contacts. Heating of contacts in electrical devices.
Electric arc disconnection and arc extinguishing devices of high-voltage circuit breakers. Normalized transient recovery voltage.
Current and voltage measuring transformers, surge arresters. Automatic low-voltage circuit breakers; arc extinguishing low-voltage devices of AC and DC current; semiconductor electrical devices.

Parameters of sulfur hexafluoride and vacuum as an insulating and arc extinguishing environment, their disadvantages when used in high-voltage circuit breakers; complete switchgears with sulfur hexafluoride high-voltage insulation.

References
1. Electrical Control and Automation Equipment: Study Manual. / S.M. Apollonsky, Yu.V. Kuklev, V.Ya. Frolov; St. Petersburg: Lan Publishing House, 2017. -256 p.: ill. (Textbooks for universities. Special literature).
2. High-Voltage AC Switches: Study Manual / E.N. Tonkonognov; St. Petersburg State Polytechnic University. - St. Petersburg: Polytechnical University Publishing House, 2015, p. 263. https://elib.spbstu.ru/dl/2/si20-68.pdf/info
3. High-Voltage Electrical Devices: Study Manual for Universities / G.N. Alexandrov et. al.; edited by G.N. Alexandrov. – 2nd ed., reworked and expanded. St. Petersburg: St. Petersburg State Technical University Publishing House, 2000, p.503.

4. Electrotechnical materials
Conductors, semiconductors, dielectrics and their classification.
Electrical conductivity of materials; polarization, dielectric losses.
Breakdown of dielectrics; aging of dielectrics, chemical structure and properties of polymers.
Classification of electrical insulation systems; requirements for electrical insulation of electric power and electrical equipment, insulation of cables, wires, electric capacitors. Typical designs and technologies for their manufacturing; capacitor insulation systems and conductive materials. Cable groups, their choice and design principles.
Uninsulated wires for power lines, power cables and cable lines; fiber optic cables.

References
1. Samusenko A.V. Stishkov Yu.K. "Electrophysical Processes in Gases Exposed to Strong Electric Fields" SPSU Publishing House. SPb. 2011. -566 p.
2. Blythe E.R., Bloor D. Electrical Properties of Polymers. Fizmatlit Publishing House - 2008 ISBN: 978-5-9221-0893-5. – 378 p.
3. Iorgachev D.V., Bondarenko O.V. Fiber Optic Cables and Communication Lines. Ecotrade Publishing House. M. 2002. – 321 p.

5. Electrical systems and grids
General information about electric power systems. Characteristics of equipment of power lines and substations. Types of electrical grid configurations.
Electric loads of electrical grid nodes. Equivalent circuits of power lines, transformers and auto transformers. Calculation of operation modes of electric power systems. Balances of active and reactive power in the power system, quality of electricity.
Voltage and frequency regulation in the electric power system.
Transient processes in electrical systems; classification of transient processes, causes of origin.
Concepts of sustainability in electric power systems, measures to increase sustainability. Short-circuit current and its properties. The method of symmetrical components.

References
1. Kostin V.N. Electric Power Systems and Grids: Study Manual. - St. Petersburg: Trinity Bridge, 2015. 304 p.: ill.
2. Evdokunin G.A. Electrical Systems and Grids: Study Manual for Students of Electrical Engineering Majors of Universities. 3rd ed., corrected and expanded - St. Petersburg, Synthesis Book LLC, 2011. 288 p.: ill.
3. Electromechanical transients in electric power systems: studies. manual / A.N. Belyaev [et al.]. – St. Petersburg: Publishing House, 2017. – 156 p.
4. Electromagnetic Transient Processes in Electric Power Systems: Study Manual / A.N. Belyaev et al. St. Petersburg: Polytechnical University Publishing House, 2012. 149 p.
5. Electrical Systems and Networks: Study Manual / A.S. Brilinsky et. al. St. Petersburg: POLYTECHPRESS, 2020. 174 p.

6. High voltage technologies
Types of electrical insulation of high-voltage equipment. Insulation of overhead lines.
Lightning protection of overhead lines. Insulation of electrical equipment at power stations and substations, closed and open distribution devices. Sulfur hexafluoride insulation; internal insulation of high-voltage plants.
Insulation of high-voltage cables and capacitors. Lightning protection and electromagnetic compatibility of equipment of power stations and substations. Protection of electrical insulation from internal overvoltages.
The basics of high voltage measurements and tests, high-voltage test rigs: pulse voltage generators, constant voltage and industrial frequency test rigs.

References
1. High-Voltage Technologies: A Textbook for Universities in the "Technical Physics" bachelors' major / Y.N. Bocharov, S.M. Dudkin, V.V. Titkov; Urait Publishing House, Universities of Russia series, 2016 https://elib.spbstu.ru/dl/2/s16-41.pdf/info
2. V.Titkov, F. Khalilov Overvoltages and Lightning Protection, study manual, "Lan," 2016.

7. Power stations
Synchronous turbo and hydro generators: rotor and stator design. Engine room layout of the power plant, the excitation system, the cooling system, the basic parameters of synchronized generators.
Generators, startup and synchronization, parallel operation of generators, generator operation.
Compensation of reactive power in the power system, voltage control in the nodes of the power system using synchronous compensators.
Startup of synchronized compensators, operation of turbo- and hydro generators in the synchronous compensator mode, transition of the synchronous machine to the synchronous compensator mode, the design features of synchronized compensators.
Complete low- and medium voltage conductors; flexible and rigid busbars of high-voltage switchgears.
Static reactive power compensation devices: capacitor batteries: design, applications, commutation features; static tyristor compensators: operation principles, types. Longitudinal compensation devices in the form of serially connected capacitor batteries; shunt reactors.

References
1. Foundations of Modern Energy: in 2 volumes : a textbook for universities in the majors "Heat Power Engineering," "Electrical Engineering," "Energy Engineering" / under the general ed. E.V. Amethysov. – 5th ed., stereotypical. - M.: MEI Publishing House, 2010. https://elib.spbstu.ru/dl/2/si20-171.pdf/info
2. Operation Modes of Electrical Equipment of Power Substations / Chernovets A.K., Lapidus A.A. - SPbSPU Publishing House, 2006.
3. Electrical Part of Power Supply Systems of Power Plants and Substations / Chernovets A.K., Lapidus A.A. - SPbSPU Publishing House, 2006

8. 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
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 и газа 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.

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

Entrance exam assessment criteria

The final score is determined by the percentage scored from the maximum number of test points, the essay is evaluated according to the following criteria: disclosure of the topic, the volume of the text, the volume of the original text.

Assigned group

Chairman of the Subject Committee:
Director of IE, V.V. Barskov.
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