KAZAKH NATIONAL UNIVERSITY NAMED AFTER AL-FARABI

Approved at the meeting
scientific and methodological
council al-Farabi KazNU
protocol No.6 of “22” June 2020
Vice-rector for academic affairs
_____ A. K. Khikmetov

PROGRAM ENTRANCE EXAMINATION
ON EDUCATIONAL PROGRAM
«8D07108 – Electric Power Engineering»
FOR APPLICANTS TO DOCTORS PhD

ALMATY 2020

The entrance exam program is based on the state standard of the Republic of Kazakhstan in the specialty "8D07108– Electric power engineering".

The program was reviewed at the meeting of the Department of plasma physics, nanotechnology and computer physics

Protocol No __of_____ 2020

Head of department PPhN and KPh _____ Kodanova S. K.

Approved at the meeting of the faculty's method Bureau
Protocol No __ of _____ 2020

The Chairman of the methodical Bureau _____ Gabdullina A. T.

Approved by the Academic Council of the faculty
Protocol No__ of _____ 2020

Chairman of the Academic Council,
dean of faculty _____ Davletov A. E.

Scientific secretary _____ Masheeva R. U.

CONTENT

1. Goals and objectives of the entrance exam in the specialty:

The entrance exam is designed to determine the practical and theoretical training of an applicant for a PhD degree and is conducted in order to determine whether the qualifications of applicants meet the requirements for doctoral studies.Вступительныйthe exam is conducted in writing.

2. Requirements for the level of training of persons entering the doctoral program:

In the PhD exam, the applicant must demonstrate

– knowledge of fundamental laws of theoretical electrical engineering, electronics, theory of electrical machines and apparatus, theory of power systems management.

– knowledge of the methodology for analysis and calculation of electrical and Electromechanical circuits, the principles of electronic devices, the device of electrical machines and devices, relay protection, the principles of obtaining and converting electrical energy, including non-traditional and alternative methods.

– knowledge of principles of power system, electrical part of stations and device stations and substations, distribution networks and networks of high and low voltage, high voltage equipment and devices, power systems and protection, stability and electric power quality.

– presentation of current problems in the energy sector, the current state of equipment and technologies in traditional and non-traditional electric power, trends in the development of renewable electricity and smart technologies.

3. Prerequisites educational programs:

1) Physical foundations of high-voltage engineering
2) Electricmachines
3) Industrialelectronics
4) Electric power, renewable and alternative energy

4. List of exam topics to prepare for the exam

Physical foundations of high-voltage engineering

Forms of electric fields in gas discharge physics. Ionization coefficients and electron avalanche. Theoretical description of electron avalanche formation. The condition of independence of the discharge. Streamer formation. Paschen's Law. Gas breakdown voltage. Discharges in gases, liquids, and solid dielectrics. High-voltage insulation. Features of pulse test installations. Methods for measuring high voltages. Overvoltage and protection against them. Generators, transformers, air and cable lines, capacitors. Types and types of overvoltage. Methods for protection from direct lightning strikes. Characteristics of arc-extinguishing devices. Vacuum devices and technologies. Electrophysical technologies. Physical properties of electrical materials.

List of recommended literature

Main:

1. Technique of high stresses / I. M. Bogatenkov, Yu. N. Bocharov, N. I. Gumerova, G. M. Imanov, etc. Edited by G. S. Kuchinsky. Saint Petersburg: Energoatomizdat, 2003, 608 p.

2. High-voltage./ Edited by G. S. Kuchinsky. Saint Petersburg: PEIPK Publishing house, 1998. 700 p.

3. High-voltage./ Edited By M. V. Kostenko. - Moscow: Higher school, 1973. - 528 p.

4. Bazutkin V. V., Larionov V. P., Pintal Yu. S. Technique of high voltages. - Moscow: Energoatomizdat, 1986. - 464 p.

5. High-voltage/ Ed. by D. V. Razevig. - M.-L.: Energiya, 1963. - 471 p.

Additional:

1. Francis G. Ionization phenomena in gases. Moscow: Atomizdat, 1964.

2. Opening F. Electrical discharges in gases. Ed. Foreign literature, Moscow, 1960, 95 p.

3. Rozanov P. N. Vacuum engineering: Moscow: Mashinostroenie, 1982. - 218 p.

4. High-voltage. / Ed. by D. V. Razevig. - Moscow: Energiya, 1976. - 488s.

5. B. M. Smirnov. Physics of weakly ionized gas, Moscow, Nauka,1972, 416 p.

6. B. N. Shvilkin. Gas electronics and plasma physics in problems. M. Nauka 1978.

Online resources:

1. http://www.inp.nsk.su
2. http://www.netref.ru

Semiconductor device

Classification of semiconductor devices. Semiconductor resistors, thermistors, and varistors. Semiconductor diode. Rectifier diode. Bipolar and field-effect transistors. Thyristors and their characteristics. Designations of semiconductor devices. The device of the optocoupler and frequency characteristics. The light emitter and the photodetector.

Amplifier circuits

Amplifying stages on a bipolar transistor. Amplifier stages on a field-effect transistor. Thermal stabilization of amplifier stages. Voltage amplifiers with resistive-capacitive coupling. Feedback. DC amplifiers. Methods for adjusting the UPT drift. AC amplifiers. Operational amplifier. Schemes of inverting and non-inverting amplifier. Selective amplifiers. Power amplifier. Nonlinear distortion in amplifiers. Classes of power amplifiers. Electronic generators of harmonic vibrations.

Electronic circuits and key circuits

Classification of secondary power supply devices. Single-phase and three-phase rectifiers. Smoothing filter. The stabilizers of voltage and current. Linear-

pulse circuits on OU, Comparators, and timers. Transistor and diode key circuits. IGBT transistors. Switching power supply. Voltage-to-current converters

Digital devices and microprocessors

Basic concepts and definitions of digital electronics. Logic level. Logic gate. Function. Elements with three States, elements with an open collector. Synthesis of combinational logic. Sequential logic. Decoders, triggers, and counters. Digital-to-analog converters: types, conversion methods, errors. Analog-to-digital converters: types, conversion methods, errors. Architecture of the MP. Hardware and software implementation of MP systems. Programmable relays, Microcontrollers and their characteristics.

List of recommended literature

Main:

1. Fundamentals of industrial electronics. Textbook for Universities. Ed. Prof. V. G. Gerasimova. M.-higher school of Economics, 1986. 3rd ed., 336 p.

2. P. Horowitz, W. Hill. The art of circuit design. in 3 volumes. Vol. 1. TRANS. with eng. 4th ed., M. Mir 1993, 413 p

3. electrical Engineering and electronics: Textbook for universities. In 3 books. Book 3. Electrical measurements and basics of electronics. / Edited by prof. V. G. Gerasimov. - Moscow: Energoatomizdat, 1998. - 432 p.

4. Collection of problems in electrical engineering and the basics of electronics: Textbook for non-electrotechnics. special education institutions. Edited by V. G. Gerasimov, Moscow: higher school of Economics, 1987.

5. Kartashev G. A. Digital electronics on a personal computer. Hotline Telecom, 2003, 311c.

6. Korolev G. V. Electronic devices of automation. M. VSH, 1991, 256 p.

7. Zhukeshov A. M. Automated production systems. Almaty: Kazak Universiteti, 2006, 134 p.

Additional:

1. Rathor T. S. The world of electronics. Digital measurement. Methods and circuitry. M. Technosphere, 2004. 376 p.

2. electrical Engineering and electronics: Textbook for universities. /Under the editorship of B. I. Petlenko. – Moscow: Academy, 2003. – 230 with

3. Danilov I. A., Ivanov P. I. General electrical engineering with the basics of electronics: Textbook-M.: HSE, 2000. - 752 p.

4. Pryanishnikov V. A. electronics: a Complete course of lectures – - 3rd ed., ISPR. and additional – SPb.: Teacher and pupil: KORONA print, 2003. - 416 p., ill.

5. Lachin V. I. Electronics. – M.:higher school, 2000.

Transformers

Purpose and role of transformers in power engineering. Device and principle of operation. Physical processes in the transformer at idle and short circuit. The EMF equation. Transformation ratio. Led transformer. Transformer operation under load. Vector diagram. Equivalent circuit. External characteristic. The

experimental determination of the parameters. Losses and efficiency of transformers.

Three-phase transformers

Features of physical processes in three-phase transformers with separate and common magnetic systems. Connection diagrams of windings, groups. Features of idling of three-phase transformers. Parallel operation of transformers. Conditions for enabling parallel work. The distribution of load between transformers in parallel operation.

Asynchronous machine

Design, principles of operation. Three-phase asynchronous machine with a rotating rotor. Voltage and current equations, substitution diagram, and vector diagram of an asynchronous machine. Asynchronous machine torque and its dependence on sliding, voltage parameters. Initial, nominal, and maximum torque. Start up and regulation of asynchronous machines. Start-up of asynchronous motors with a short-circuited rotor and contact rings. Deep-range engines. Two-cell engines. Speed control of three-phase asynchronous motors with short-circuit and phase rotor by the action of the stator and rotor.

Synchronous machine

Device and principle of operation. Armature reaction in a synchronous generator. Characteristics of synchronous generators. Parallel operation of synchronous generators. Methods for starting synchronous motors. Vector diagram of a synchronous motor. Influence of the field current value on the synchronous motor operation. Performance characteristics of synchronous motors. Angular characteristics of synchronous machines. Special types of synchronous machines. Synchronous compensator.

DC machines

The main elements of the design, the principle of operation, the principle of reversibility. Electromotive force of the armature winding. Magnetic field in the air gap of the machine. Types of anchor reaction and its influence on the machine operation. General concepts of current switching. DC generators. Classification of generators by way of excitation. The energy diagram, the equation of the EMF, electromagnetic torque. Characteristics of generators with independent, parallel, sequential and mixed excitation. DC motor. DC motor. Energy diagram. Equations of stresses, velocities, and moments. Start-up and start-up characteristics. Mechanical characteristics of DC motors with different excitation schemes. Speed control of DC motors with various excitation schemes. Losses and efficiency of DC machines.

List of recommended literature

Main:

1. Voldek A. I., Popov V. V. Electric machines. AC machines: Textbook for universities. Saint Petersburg: Piter, 2008. 350 p.

2. Kopylov I. P. Electric machines. Textbook for universities. - Moscow: Energoatomizdat, 2000. - 360 p.

3. Katsman M. M. Electric machines. - M.: Higher School; Publishing center "Academy"; 2001. - 463 p.

4. Tokarev B. F. Electric machines. Textbook for universities. - Moscow: Energoatomizdat, 1990. - 624 p.

5. Bruskin D. E., Zorokhovich A. E., Khvostov V. S. Electric machines. Textbook for universities. - M.: Higher school, 1987. Part 1-360 p., part 2-332 p.

6. Ignatovich V. M., roiz sh. S. Electric machines and transformers: Textbook. - Tomsk: TPU Publishing house, 2010. -147 p.

Additional:

1. Tikhomirov P. M. Calculation of transformers. Textbook for universities. 5-e Izd., reprocessing. and add. - M.: Energoatomizdat, 2009. - 528 p.

2. Ignatovich V. M., roiz sh. S. Electric machines and transformers. Guidelines for the study of the disciplines "Electric machines" and "Electromechanics". Tomsk: TPU Publishing house, 1999, 20 p.

3. verhoturov A. I., Golemgrain V. V., Ignatovich V. M., roiz sh. S. Electric machines and transformers. Control questions in the defense of laboratory work on the discipline "Electromechanics". Tomsk: TPU Publishing house, 2005, 25 p.

Basics of electric power industry

Brief history of electric power industry. Electric power system. Electric networks 10-1250 kV. Energy Of Kazakhstan. Synchronous generator designs. The principle of operation of synchronous generators. Types of turbo and hydro generators by capacity and cooling methods. Characteristics of generators running on an Autonomous network. The principle of operation and device of the transformer. Autotransformers. The design of the transformer. Losses and efficiency of the transformer. Instrument transformer.

Transmission and consumption of electric energy

High-voltage switching and protection devices. Operating conditions of high-voltage devices and General requirements for them. High-voltage switches. Disconnectors, separators, short-circuit breakers. Protective and current-limiting devices. Electrical diagrams of power plants and substations. Classification of switchgear schemes. Typical grid of distribution device diagrams. Structural diagrams of power stations. Reactive power in the electrical network. Reactive power sources and their purpose Types of reactive power sources. Synchronous generators of power plants. General characteristics of power supply systems. The main groups of electricity consumers. Basic conditions and tasks of forming power supply systems. Rated voltage of electrical installations. The main types of schemes of electric networks are the neutral Mode of electric networks. Structures of lines, substations and their main electrical equipment. Main issues of SES design and calculations.

Management of EPS and quality of electricity

Classification of modes of power system Transients, and processes of Normative indicators of sustainability and provision of management modes and

their functions. Basic principles of dispatching control Hierarchical system of dispatching control of UES Temporary levels of control of modes of UES Automated system of dispatching control Structure of emergency automation system. The value of kachesvto of electrical energy. Energy quality indicators Influence of electricity quality on the functioning of technical means.

Renewable and alternative energy

Classification of solar power installations. Thermoelectric converters, operating principle, efficiency, advantages and disadvantages. Photoelectric converters, operating principle, efficiency, advantages and disadvantages. Concentrating suntrap. Scheme, operating principle, advantages and disadvantages of steam turbine SES. Heating system with solar collectors. Experience of foreign countries in the use of wind energy. Classification of wind turbines by classes of wind engines, advantages and disadvantages of classes. Scheme of a wind power plant, features and principle of operation. Classification of wind power plants for power generation. The main provisions of the theory of an ideal windmill. The main provisions of the theory of a real windmill. Modes of operation of wind turbines. Prospects for the use of wind energy. Negative phenomena in the operation of wind turbines. Types of geothermal energy sources. Classification of geothermal areas. Prospects for using geothermal energy, advantages and disadvantages. Methods and methods of using geothermal heat. Use of geothermal heat in heat supply systems. Scheme and principle of operation of the simplest geothermal power Plant. Nuclear station. Thermonuclear power.

1. List of recommended literature

2. Main:

3. 3. Fundamentals of modern energy: A course of lectures for managers of energy companies. In two parts. / Part 2. Modern power industry / Under the editorship of professors A. p. Burman and V. A. Stroev. - Moscow: publishing house of MEI, 2003. - 454 p., ill.
4. 4. Electric devices of high voltage with gas isolation / ed. by Yu. I. Vishnevsky. S. - Pb.:Energoatomizdat, 2002.
5. 5. Electric part of stations and substations / A. A. Vasiliev, I. P. Kryuchkov, E. F. Nayashkova, M. N. Okolovich. M.: Energoatomizdat, 1990.
6. 6. Electrical systems. Electrical networks / Venikov V. A., Glazunov A. A., Zhukov L. A. and others.; Ed. Stroeva V. A.-2nd ed., pererab. and add. M.: Higher school, 1998.
7. 7. Electrical systems. Electrical networks: Textbook. for electric power specialties of higher education institutions / Ed. Venikova V. A., Stroeva V. A.-2nd ed. Moscow: Higher school, 1998.
8. 8. Gorodov V. E., Gubin A. S., Matveev R. V. non-Traditional and renewable energy sources: textbook / Tomsk, TPU, 2009, 293 p
9. 9. Sibikin Yu. D. non-Traditional and renewable energy sources: textbook-M.: KNORUS, 2010. - 232 p

Additional:

1. Electrical and electronic devices / Edited by Yu. K. Rozanov M.: Informelectro, 2001.

2. Solar energy: TRANS.with English and French./ Under the editorship of Yu. N. Makovsky and M. M. Koltun. - M.: Mir, 1979. - 390s.

3. Wind energy/Ed. by D. Renzo. - Moscow: Energoatomizdat, 1982.

4. Dvorov I. M. Geothermal power engineering. - Moscow: Nauka, 1976.

5. World energy Council (WEC): forecasts of energy development // Energy abroad. - 2000. - № 3.

Scale of assessment of exams for applicants to the doctoral program in OP "8D07108- Electric Power Engineering"

Each answer to the exam ticket question is evaluated on a 100-point scale. The final score for the exam is output as the arithmetic average of the scores for all the answers.

The examination Commission conducts the discussion and final evaluation of applicants ' responses to the PhD degree at a closed meeting, determining the final rating – "excellent", "good", "satisfactory", "unsatisfactory", expressed in points.

Assessments are announced on the same day after the minutes of the meeting of the State attestation Commission are drawn up in accordance with the established procedure.

When conducting the exam in writing, the following criteria are set for evaluating the knowledge of graduates:

<table>
<tr><th>Characteristics of the master's work</th><th>Range of rating points</th><th>Letter grade</th><th colspan="2">Traditional (4-level) ratingscale</th></tr>
<tr><td rowspan="2">"Excellent" – a work of high quality, the level of performance meets all requirements, the theoretical content of the course is mastered completely, with no gaps, necessary practical skills of work with the mastered material are formed, all provided by the training program learning tasks fulfilled, the quality of their performance assessed by the number of points close to maximum</td><td rowspan="2">90-100</td><td>A</td><td rowspan="2">excellent</td><td rowspan="3">readout</td></tr>
<tr><td>A-</td></tr>
<tr><td rowspan="2">"Very good" – work is good, the level of performance meets most of the requirements, the theoretical content of the course is mastered completely, with no gaps, necessary practical skills mastered the material mainly formed, all provided</td><td rowspan="2">80-89</td><td>B+</td><td rowspan="2">good</td></tr>
<tr><td>B</td></tr>
</table>

Characteristics of the master's work	Range of rating points	Letter grade	Traditional (4-level) ratingscale	
by the training program learning tasks fulfilled, the quality of most of them are valued by the number of points close to maximum		B-		
"Well" – a level of performance that meets all the basic requirements, the theoretical content of the course is mastered completely, without gaps, some practical skills of work with the mastered material are formed is not enough, all provided by the training program learning tasks fulfilled, the quality of performance none estimated minimum number of points, some of the assignments may contain errors	70-79	C+	satisfactorily	
		C		
		C-		
"Satisfactory" – a level of performance that meets the most basic requirements of the theoretical content of the course is mastered partially, but gaps are not essential, are necessary practical skills mastered the material are basically formed, most provided by the training program learning tasks fulfilled, some job completed with errors	60-69	D+	satisfactorily	readout
		D		
"Mediocre" - the work is weak, the level of performance does not meet most requirements, the theoretical content of the course is partially mastered, some practical skills are not formed, many of the	50-59	D-		

Characteristics of the master's work	Range of rating points	Letter grade	Traditional (4-level) ratingscale	
training tasks provided by the training program are not completed, or the quality of some of them is estimated by the number of points close to the minimum				
"Unsatisfactory" (with a chance to retake the exam) – theoretical course content mastered in part, necessary practical skills are not formed, most provided by the training program learning tasks are not fulfilled, or the quality of their performance assessed by the number of points close to minimum; with additional individual work on the course material may increase the quality of performance of educational tasks	25-49	FX	unsatisfactorily	notcounted
"Unsatisfactory" – without the possibility of retaking) - the theoretical content of the course is not mastered, the necessary practical skills are not formed, all completed training tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of training tasks	0-24	F		