AL-FARABI KAZAKH NATIONAL UNIVERSITY

Approved
at the meeting of the academic committee (SMC)
of Al-Farabi Kazakh National University
Vice Rector for Academic Affairs

_____A.K. Khikmetov
Minutes No. 6 dated June 22, 2020

ENTRANCE EXAMINATION PROGRAM
FOR ADMISSIONS TO THE DOCTOCAL PROGRAMME
ON THE EDUCATIONAL PROGRAM "8D07107-ALTERNATIVE ENERGY"

ALMATY 2020

The program is compiled in accordance with the curriculum for the educational program "8D07107-ALTERNATIVE ENERGY".

The program was compiled by Doctor of Physical and Mathematical Sciences, Professor A.S. Askarova and Doctor of Physical and Mathematical Sciences, Professor S.A. Bolegenova.

The program was considered at the meeting of the Department of Thermophysics and Technical Physics
Minutes No. 38 dated 05.19.2020

Head of Department _____ Bolegenova S.A.

Approved at the meeting of the method bureau of the Faculty of Physics and Technology
Protocol No. ___ dated _____.2020

Chairman of the method bureau _____ Gabdullina A.T.

Approved at the meeting of the Scientific Council
Minutes No. 9 dated 05.29.2020

Chairman of the Scientific Council,

Dean of the Faculty _____ Davletov A.E.

Scientific Secretary _____ Masheeva R.U.

CONTENT

1. Goals and objectives of the entrance exam on the educational program "8D07107-ALTERNATIVE ENERGY".

The entrance exam is intended to determine the practical and theoretical readiness of the Master's Degree Students and is carried out in order to determine the conformity of knowledge and skills of students to the requirements of doctoral studies in the direction of training.

To achieve this goal, it is necessary to carry out the following tasks:

- comprehensive and systematic study of natural science subjects;
- formation of skills of the independent scientific and theoretical analysis;
- mastering the methods of studying physics;
- development of pedagogical and research skills.

The entrance exam form is a written exam. Examiners record their answers to questions on the exam ticket on the answer sheets. In the event of an appeal, the basis for consideration is the written notes in the answer sheet.

2. Requirements for the level of training of people entering PhD doctoral studies

Requirements for applicants wishing to master the educational doctoral programs on the educational program "8D07107-ALTERNATIVE ENERGY":

Applicant must:

- *be able to* freely navigate in fundamental and applied issues of that field of physics, for which profile specialization was carried out as part of the educational program of the magistracy;
- *have an idea* of the latest achievements of science and technology;
- *known* contemporary experimental, theoretical and numerical methods for the study of physical phenomena and processes; actual problems of physics.

3. Prerequisites for the educational program

1. Information systems in heat power engineering and heat technology – 3 credits.
2. Scientific and technical problems of heat power engineering and heat technology – 3 credits.
3. Industrial power saving systems – 3 credits.

4. Exam topics

Discipline "Information systems in the heat power industry and heat technology"

Models and types of modeling. Types of modeling. Analog simulation. Physical modeling. Criteria equations for problems of heat conductivity, convective and radiative heat transfer. Mathematical modeling as the main method for solving problems of optimization and design of heat technology processes.

Numerical methods for solving some heat engineering problems. Numerical integration (rectangle, trapezoid, parabolas and Gauss methods) when calculating the heating surface area of a heat exchanger. Finding the roots of algebraic and transcendental equations when solving the criteria equations of heat and mass transfer. Solution of the systems of linear and nonlinear algebraic equations, ordinary differential equations describing heat engineering processes. Numerical methods and their computer implementation when solving problems of heat and mass transfer and hydrodynamics. Methods of integral relations, finite-difference methods for solving the problem of viscous flow of liquids and gases in a boundary layer with an external flow around bodies. Application of the sweep method in problems of flow modeling in channels. Optimization problems in the power industry and heat engineering.

Mathematical modeling and optimization of heat and mass transfer apparatus. Mathematical description of the flow structure in the apparatus. Models of perfect mixing and perfect displacement. Diffusion model, cell model. Combined models. Modeling the operation of

the regenerative heat exchanger. Statement of the problem of optimization of the heat exchanger. Modeling and optimization of the operation of distilling apparatus and rectifying still. Automation of mathematical modeling of heat and mass transfer apparatus.

Mathematical modeling and optimization of heat and energy supply systems of industrial enterprises. Simulation models of heat and energy supply systems for industrial enterprises (HESSIE) and their features. Accuracy of the implementation of mathematical models for HESSIE. Automation of mathematical modeling of HESSIE. Mathematical models of steam, condensate and water heat networks. Use of mathematical models to study the hydraulic and thermal modes of networks. Mathematical models of boiler houses and their elements. Using mathematical models of thermal power plants for the analysis of thermal circuits, equipment operating modes and economic indicators. General methods and principles of the approach to solving problems of optimization of complex energy systems and installations.

Modeling and optimization of processes in the main equipment of thermal power plants. Numerical calculation of the process of expansion of steam in the turbine stage and in the turbine as a whole. Calculation of the steam turbine installation with a regeneration system. Numerical calculation of the combustion process in a boiler unit and the equilibrium composition of the combustion products. Methods, their accuracy and computer implementation. Optimization of coolant speed and pipe diameter in the heat exchanger. Optimization of gas turbine unit parameters. Optimization of load distribution between TPP units and energy characteristics of steam turbines and boiler units. Equations for characterization of cogeneration turbines.

Application program packages for solving heat-engineering problems. Packages of applied programs (APP) and data banks (DB) of heat technology: analysis, use and development. Structure and properties of application program packages (APP). Development and testing of APP. Opportunities of APP and management of its work. Use of APP for CAD. Using the Visio system for the design of heat engineering schemes.

Automated research systems. Heat-engineering reference and information systems and data banks. Automated data systems and thermodynamic properties of substances. Complexes of applied programs for modeling the processes of hydrodynamics, heat and mass transfer. Automated systems for modeling heat power equipment.

Discipline "Scientific and technical problems of heat power engineering and heat technology"

Scientific and technical problems of heat power engineering and heat technology

Special issues of heat and mass transfer. Methods of intensification of heat and mass transfer. Mathematical modeling and numerical methods for solving heat and mass transfer problems. Special issues of the theory of combustion. Predictive analysis of energy technologies and structures. Mathematical modeling in predictive analysis.

Current state and perspective directions of heat and electric energy

Current state and promising methods and methods of obtaining and converting heat and electric energy. Problems and prospects for the development and improvement of the basic equipment of power plants and technological schemes. Problems and prospects for the development and improvement of ways and methods for the preparation and burning of fuel, the use of secondary energy resources and industrial waste as energy fuel. Ensuring the reliability of power equipment operation. Optimization of the development of energy systems and power plants. Problems of reconstruction and modernization of heat power equipment of heat power works and facilities.

Alternative and renewable energy sources

Problems and prospects of using non-traditional and renewable energy sources for energy supply of united and autonomous consumers. Ecological problems of heat power engineering.

Energy development

Analysis of trends and patterns of energy development (globalization, liberalization, diversification, decentralization, modernization). Development of energy policy and mechanisms for its implementation. Energy security of the country.

Calculation of energy characteristics

Thermal and hydraulic calculation of the heat exchanger apparatus. Methods of reconstruction of boilers in connection with the transfer to another type of fuel. Calculation of energy characteristics of heat technology production. Calculation of energy efficiency indicators in the fuel and energy sector and industries. Calculation of solar energy installations. Calculation of bioenergy plants. Drawing up energy certificates of an industrial enterprise and housing and communal services.

Discipline "Industrial power supply systems"

Power stations

Reasons for creating power systems. Electric networks and receivers of electric energy. Schedules of loads and the quality of electrical energy. Power systems and power plants. Electric power networks. Receivers of electrical energy. Graphs of loads of electrical energy. Quality of electrical energy.

Power supply systems

Power supply systems. Heat supply systems. Problems of heat supply systems. Calculation of power supply systems. Methodology for calculating energy supply systems.

Thermal energy

Sources of thermal energy. Thermal networks and their equipment. Consumers of thermal energy. Methods for calculating the amount of heat from sources of thermal energy.

Water supply

Heating and hot water supply. Ventilation and air conditioning.

Fuel supply

Fuel supply for solid fuels. Fuel supply with liquid fuel. Fuel supply with gaseous fuels. Centralized and decentralized methods of producing artificial cold.

5. References

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6. Scale for assessing the results of the entrance exam for the doctoral program "8D07107-ALTERNATIVE ENERGY"

Letter grade	Digital equivalent of points	% content	Traditional system assessment	Competency scale
A	4.0	95-100	Excellent	This assessment is given if the applicant: 1) has an idea of: the main stages of development and shift of the paradigm in the evolution of science; scientific schools of the corresponding branch of knowledge, their theoretical and practical developments; scientific concepts of world and Kazakhstani science in the relevant field; the mechanism for introducing scientific research into practical activities. 2) knows and understands modern trends, directions and patterns of the development of domestic science in the context of globalization and internationalization; perfectly knows a foreign language for the implementation of scientific communication and international cooperation. 3) able to: organize, plan and implement a research process; analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions; analyze and process information from various sources; plan and predict his (her) further professional development. 4) has the skills of: critical analysis, evaluation and comparison of various scientific theories and ideas; analytical and experimental scientific activity; planning and forecasting research results; oratory and public speaking at international scientific forums, conferences and seminars.

A-	3.67	90-94		This assessment is given if the applicant:: 1) has an idea of: scientific schools of the corresponding branch of knowledge, their theoretical and practical developments; scientific concepts of Kazakhstani science in the relevant field; the mechanism for introducing scientific research into practical activities. 2) knows and understands modern trends, directions and patterns of the development of domestic science in the context of globalization and internationalization; perfectly knows a foreign language for the implementation of scientific communication and international cooperation. 3) able to: organize, plan and implement a research process; analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions; analyze and process information from various sources; plan and predict his (her) further professional development. 4) has the skills of: evaluation and comparison of various scientific theories and ideas; analytical and experimental scientific activity; planning and forecasting research results; oratory and public speaking at international scientific forums, conferences and seminars.
B+	3.33	85-89	Good	This assessment is given if the applicant: 1) has an idea of: scientific schools of the corresponding branch of knowledge, their theoretical and practical developments; scientific concepts of Kazakhstani science in the relevant field. 2) knows and understands modern trends, directions and patterns of the development of science in the context of globalization and internationalization; perfectly knows a foreign language for the implementation of scientific communication and international cooperation. 3) able to: organize and implement a research process; analyze and compare various theoretical concepts in the field of research and draw conclusions; analyze information from various sources; plan and predict his (her) further professional development. 4) has the skills of: evaluation of various scientific theories and ideas; analytical and experimental scientific activity; planning and forecasting research results; oratory and public speaking at international scientific forums, conferences and seminars.

B	3.0	80-84		This assessment is given if the applicant: 1) has an idea of: scientific schools of the corresponding branch of knowledge, their theoretical and practical developments.. 2) knows and understands modern trends, directions and patterns of the development of science in the context of globalization and internationalization; knows a foreign language for the implementation of scientific communication and international cooperation. 3) able to: organize and implement a research process; analyze and compare various theoretical concepts in the field of research and draw conclusions; analyze information from various sources; plan and predict his (her) further professional development. 4) has the skills of: analysis and comparison of analytical and experimental scientific activity; planning and forecasting research results; oratory and public speaking at international scientific forums, conferences and seminars.
B-	2.67	75-79		This assessment is given if the applicant: 1) has an idea of: scientific schools of the corresponding branch of knowledge, their theoretical developments; scientific concepts of Kazakhstani science in the relevant field. 2) knows and understands modern trends, directions and patterns of the development of science in the context of globalization and internationalization; knows a foreign language for the implementation of scientific communication and international cooperation. 3) able to: organize and implement a research process; analyze various theoretical concepts in the field of research; analyze information from various sources; plan his (her) further professional development. 4) has the skills of: evaluation and comparison of analytical and experimental scientific activity; oratory and public speaking at international scientific forums, conferences and seminars.