Institute of Energy and Mechanical Engineering
Department of General Physics

EDUCATIONAL PROGRAM

6B07129 - Nuclear energy
cipher and name of the educational program

Education code and classification: **6B07 Engineering, manufacturing and construction industries**
Code and classification of areas of study: **6B071 Engineering and Engineering**
Group of educational programs: **B062 Electrical engineering and power engineering**
Level according to the SQF: **6**
Level according to the NQF: **6**
Duration of study: **4 years**
Volume of credits: **240 credits**

Almaty2024

Educational program 6B07129 "Nuclear Energy" approved for meeting of the Academic Council of KazNITU named after. K.I. Satpaeva.

Protocol No. 12 dated April 22, 2024

Considered and recommended for approval at a meeting of the Educational and Methodological Council of KazNITU named after. K.I. Satpaeva.

Protocol No. 6 of April 19, 2024

Educational program 6B07129 "Nuclear Energy" was developed by the academic committee in the direction of "Engineering and Engineering"

Full name	Academic degree/ academic title	Post	Place of work	Signature
Chairman of the Academic Committee:				
Lesbayev Aidos	PhD	Head of the Department, associate professor	department of "General Physics" IEaM	
Teaching staff:				
Shalenov Erik	PhD	Associate professor	department of "General Physics"	
Employers:				
Saduev Nurzhan Orynbasarovich	PhD	Deputy director general for scientific works	Institute of Nuclear Physics	
Students				
Yermekov Ali Aigalievich		1st year student	Kazakh National Research Technical University named after K.I.Satbayev KEJSC	

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List of abbreviations and designations

NJS KazNRTU named after K.I.Satpayev – NJS "Kazakh National Research Technical University named after K.I.Satpayev"**;**
SOSE – State obligatory standard of education of the Republic of Kazakhstan;
EP – educational program;
IWS – independent work of a student (student, undergraduate, doctoral student);
IWST – independent work of a student with a teacher (independent work of a student (undergraduate, doctoral student) with a teacher);
WC – working curriculum;
CED – catalog of elective disciplines;
UC – university component;
OC – optional component;
NQF – national qualifications framework;
SQF – sectoral qualifications framework ;
LR – learning results.

1. Description of the educational program

The professional activities of the graduates of the program are directed to the field of nuclear energy, nuclear reactor technology and the nuclear fuel cycle.

The direction of the program of specialty and specialization covers engineering and engineering in the field of nuclear energy.

The field of professional activity of bachelors includes sections of science and technology containing a set of means, techniques, methods and methods of human activity aimed at ensuring the safety, reliability and efficiency of nuclear installations, as well as developing competitive solutions based on the use of modern methods and tools for modeling, calculations and design.

The subjects of professional activity of graduates of the specialty "Nuclear Energy" are: nuclear reactors and their components, control and safety systems, tools and equipment for servicing nuclear installations, design solutions, automated control systems, diagnostics and maintenance tools.

Bachelors who have received the specialty "Nuclear Energy" can perform the following types of professional activities:

– organizational and managerial, related to the planning and coordination of the work of nuclear installations;

– production and technological, including the maintenance and repair of nuclear installations;

– design and development, aimed at creating new nuclear installations and their components;

– calculation and design related to mathematical modeling and calculations of the characteristics of nuclear reactors;

– experimental research, which includes scientific research in the field of nuclear energy.

Functions of professional activity of graduates of the specialty of nuclear energy:

– design of nuclear reactors and energy production systems based on nuclear energy;

– development of technologies, methods and instruments for control of nuclear reactors and other objects related to nuclear power engineering;

– assessment of the safety of nuclear installations and energy production systems, as well as the development of measures to improve safety;

– organization and management of the production process in the nuclear power industry;

– carrying out research in the field of nuclear physics and technologies of nuclear power engineering;

– education and training of specialists in the field of nuclear energy;

– participation in the development and implementation of scientific and technical programs and projects in the field of nuclear energy;

– consulting and expertise in the field of nuclear energy;

- work with regulatory and regulatory bodies in the field of nuclear energy;

– development and implementation of new technologies and methods in the field of nuclear energy.

Graduates are prepared to solve the following types of tasks by type of professional activity:

– development of designs for nuclear reactors and other nuclear power facilities, including the design of safety and control systems;

– study of physical and technological properties of materials used in nuclear power engineering;

– development of programs and methods for training the personnel of nuclear facilities;

– risk assessment and development of measures to prevent accidents at nuclear facilities;

– development and implementation of new technologies in nuclear power, for example, to improve the performance of nuclear reactors;

– development and implementation of systems for the processing and disposal of radioactive waste;

– organization and coordination of works on construction and operation of nuclear facilities;

– work in research centers involved in the development of new technologies and materials for nuclear power;

– work in state bodies involved in the regulation of nuclear energy and control over the safety of nuclear facilities;

– advising companies and organizations using nuclear energy in their activities.

Directions of professional activity of the graduate of this specialties:

- design, development and operation of nuclear reactors and other nuclear installations;

- work with nuclear fuel and materials, including their production, processing, storage and transportation;

- development and implementation of control, safety and labor protection systems in the nuclear industry;

- research and development of new nuclear energy technologies, including nuclear energy;

- organization and management of construction and modernization of nuclear facilities;

- assessment of environmental and socio-economic consequences of the use of nuclear energy;

- work in research and educational institutions, as well as in government and private organizations related to nuclear energy;

- participation in international projects on nuclear energy and interaction with international organizations in the field of nuclear energy.

The content of professional activity in the field of nuclear energy includes a set of tools, methods and technologies necessary for the implementation of design, production, technological, organizational, economic and management activities, as well as experimental research in the field of nuclear energy. To ensure the production

of competitive products in the field of nuclear energy, modern methods of design, design work and technical analysis are used, as well as innovative technologies related to the use of nuclear energy.

Requirements for key competencies of a bachelor.

The bachelor must:

- have knowledge in the field of physics, mathematics, thermodynamics, mechanics and other scientific disciplines related to nuclear energy;
- understand the basics of nuclear physics and reactor technology, as well as be able to apply them to solve problems in the field of nuclear energy;
- be familiar with the principles and methods of nuclear fuel processing, reactor control and radiation protection;
- have knowledge in the field of design, operation and repair of nuclear reactors and other systems related to nuclear power;
- be able to work with various software products used in nuclear power, such as a program for modeling nuclear reactors and programs for data processing;
- be familiar with the principles of risk management and safety in nuclear power and be able to apply them in practice;
- have the skills of communication and cooperation with colleagues, including specialists from other fields;
- be able to work in conditions of increased responsibility and stress, ensuring the safety and reliability of nuclear systems;
- be familiar with international standards and regulations related to nuclear power;
- have the skills to analyze and solve problems related to nuclear energy, and be able to work in a team to achieve common goals.

2. Purpose and objectives of the educational program

Purpose of the EP:

The goal of training specialists in the field of nuclear energy is to prepare highly qualified and competitive personnel who will be ready to work in industrial enterprises, research centers and laboratories. Students studying in this field receive fundamental knowledge and practical skills in the field of nuclear physics, engineering and technology, as well as acquire practical skills in working at nuclear physics facilities, construction and operation of nuclear power plants.

Objectives of the EP:

- providing students with basic systemic knowledge in the field of nuclear physics, including the physics of the atomic nucleus and elementary particles, as well as relativistic nuclear physics. this will allow the formation of highly qualified specialists who will be able to solve research, production and technological tasks and problems in the field of nuclear energy;
- development of students' skills to acquire new knowledge necessary for everyday professional activities. students will also be trained in conducting design and survey research, drawing up fundamental and applied scientific projects in the field of nuclear energy;

- formation of personal qualities (the ability to learn throughout life in the context of both personal professional and social life, strive for professional and personal growth, etc.) that contribute to the development of leadership qualities and teamwork abilities in nuclear power;
- development of students' skills to navigate in modern information flows and adapt to dynamically changing phenomena and processes in the nuclear power industry.

3. Requirements for evaluating the learning outcomes of an educational program

To successfully graduate from a university and obtain a bachelor's degree, it is necessary to fulfill the generally required standard requirements, which include passing at least 240 credits of theoretical training and preparing a final thesis. These credits must be credited for the completion of all subjects included in the undergraduate curriculum. In addition, it is necessary to successfully pass all exams and defend the thesis in accordance with the established requirements. Based on the results of fulfilling all these conditions, the student will be awarded an academic bachelor's degree.

4. Passport of the educational program

4.1. General information

№	Title	Note
1	The code and classification of the field of education	6B07 Engineering, manufacturing and construction industries
2	Code and classification of areas of study	6B071 Engineering and Engineering
3	Group of educational programs	B062 Electrical engineering and power engineering
4	Educational program name	6B07129 - Nuclear energy
5	Brief description of the educational program	Graduates of the specialty "Nuclear Energy" can be engaged in the design, modeling, maintenance and operation of nuclear installations, and research in this area. Bachelors can work in companies engaged in the design and construction of nuclear installations, research institutes and laboratories, state control and supervision bodies, as well as in educational institutions. The key skills of graduates are knowledge of nuclear reactor physics, mathematical modeling, work with automated control systems and safety control systems, the ability to work in a team and make responsible decisions.
6	Purpose of the EP	The goal of training specialists in the field of nuclear energy is to prepare highly qualified and competitive personnel who will be ready to work in industrial enterprises, research centers and laboratories. Students studying in this field receive fundamental knowledge and practical skills

		in the field of nuclear physics, engineering and technology, as well as acquire practical skills in working at nuclear physics facilities, construction and operation of nuclear power plants.
7	Type of EP	Innovative
8	Level according to the NQF	6
9	Level according to the SQF	6
10	Distinctive features of the EP	Students majoring in nuclear energy will receive extensive training in mathematics, mechanics, physics and information technology. They will study the methods of analytical, experimental and numerical modeling, as well as the development of computer models of complex mechanical and physical processes. Graduates will be able to apply theoretical and experimental methods for studying problems in mechanics, as well as mathematical and computer modeling to solve engineering problems. They will also be able to model complex processes and create computer codes to solve them. This training is required for work in the field of nuclear energy, where mathematical modeling and computer technology are key in the design, development and operation of nuclear reactors and other devices and systems.
11	List of competencies of the educational program:	**General competencies** - Proficiency in Kazakh, Russian and English for free communication and work with scientific literature on nuclear energy. - Critical systems thinking, transdisciplinarity and cross-functionality. - Possession of ICT competencies and ability to develop software. - Skills of self-study and deepening of knowledge, systems thinking and own judgment. - Tolerance towards other nationalities, races, religions and cultures, as well as the ability to conduct intercultural dialogue. - Communication skills and ability to work in a team. - Willingness to work in conditions of high uncertainty and rapid change of tasks, as well as work with customer requests. - Broad social, political and professional outlook, ability to use data from various sources and analyze and evaluate historical facts and events. - Knowledge of the basics of entrepreneurial activity and business economics, readiness for social mobility **Professional competencies** - Possession of fundamental knowledge of physics, mathematics, thermodynamics and scientific principles related to nuclear energy. - Ability to independently build adequate physical and mathematical models of nuclear processes and phenomena. - Ability to use mathematical models and computer programs for independent research of a wide range of engineering problems of nuclear power and design of various nuclear systems. - Ability to develop new designs and devices, including nuclear reactors and systems associated with nuclear fuel. - Ability to work with high-tech laboratory and research equipment used in nuclear power. - Possession of algorithmic languages and programming technology, as well as the skills of computer modeling and research of complex physical and nuclear processes. - Possession of skills as a designer in the field of nuclear energy,

		including the design of nuclear installations and equipment, as well as work with nuclear fuel and radiation materials.
12	Learning outcomes of the educational program:	LO1 apply basic knowledge of the fundamental disciplines of mathematics and digital technologies in the design and preparation of production in the field of nuclear energy. LO2 apply knowledge of economic laws, labor protection and life safety, ecology, rules of moral development, culture of academic honesty at a professional level, taking into account the specifics of working with nuclear materials and ensuring safety at nuclear facilities. LO3 use key theoretical knowledge from the main areas of general and theoretical physics to solve problems related to professional activities in the field of nuclear energy. LO4 apply the basic laws of nature and the principles of natural sciences, use mathematical methods and electrical calculations to solve problems in the field of nuclear physics and nuclear energy, including problems of varying complexity. LO5 use methods of experimental, theoretical and computer research and design to determine the radioactive and chemical composition, structure and properties of materials used in nuclear power. LO6 analyze ways to ensure nuclear and radiation safety, security and control of nuclear materials, technical and environmental safety of production at the work site. LO7 perform calculations of nuclear reactions, carry out nuclear decays, obtain uranium pellets, study plasma and investigate the interaction of radiation with matter within the framework of the fundamental processes of nuclear physics, nuclear energy, thermonuclear fusion and radioecology. LO8 perform diagnostics and control of the operation of relay protection and electrical automation devices, instrumentation, microprocessor devices in electrical systems and networks, as well as design relay protection and automation of power stations and substations, having the skills to work with digital technology and microprocessor systems. LO9 analyze various methods of using beam-plasma, nuclear power, laser installations, X-ray and neutron beams in radiation materials science and nuclear physics. LO10 analyze various types of modern nuclear power plants and identify their advantages and disadvantages, make a comparative review of various types of reactors and electronic control systems, assessing their effectiveness and applicability in modern conditions.
13	Form of study	Full-time
14	Duration of study	4 years
15	Volume of credits	240
16	Teaching languages	Kazakh, Russian, English
17	Awarded Academic Degree	"Bachelor of Engineering and Technology" under the educational program "6B07129 - Nuclear Energy"
18	Developer(s) and authors:	Associate prof. Shalenov E.

4.2. The relationship between the attainability of the formed learning outcomes in the educational program and academic disciplines

№	Name of the discipline	Brief description of the discipline	Number of credits	Formed learning outcomes (codes)									
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10
Cycle of general education disciplines University component													
1.	Fundamentals of anti-corruption culture and law		5		v								
2.	Fundamentals of economics and entrepreneurship		5		v								
3.	Fundamentals of scientific research methods		5		v								
4.	Ecology and life safety		5		v								
Cycle of basic disciplines University component													
5.	Mathematics I		5	v									
6.	Mechanics. Molecular physics	The main purpose of this discipline is to create a knowledge base for the study of further sections of physics and special courses of the educational program "Nuclear Energy". The section "Mechanics" includes the fundamental laws of classical mechanics, the properties of mechanical vibrations and waves. The section "Molecular Physics" discusses models of molecular physics, the basics of molecular kinetic theory and the basics of thermodynamics. The obtained theoretical material of this discipline will allow students to solve different problems and performing laboratory workshop.	5			v	v						

7.	Electromagnetism	The purpose of mastering the discipline is to acquisition the basic competencies in the field of electromagnetism, necessary for the formation of a physical worldview and the application of this knowledge in the profession of a nuclear power engineer. As a result of mastering the discipline, the student must: Know: basic laws of electromagnetism; Be able to apply: • algorithms and methods for solving standard problems of electromagnetism for solving practical problems of nuclear power engineering; • techniques for conducting a laboratory experiment and basic methods of information processing.	5			v	v						
8.	Mathematics II		5	v									
9.	Introduction to Nuclear Energy	The main purpose of this discipline is to familiarize with the main types of primary natural energy, physical and technical principles of nuclear energy, as well as with modern problems of nuclear energy and possible ways to solve these problems. The discipline "Introduction to Nuclear Energy" contributes to the formation of students' ideas and knowledge in the field of nuclear energy, necessary for further study of specialized disciplines, research and project activities of students.	4					v	v				
10.	Mechanics of liquids and gases	The goal of the fluid and gas mechanics discipline is to equip students with the fundamental knowledge and skills necessary to analyze and solve practical problems related to the properties of liquids and gases. Application of knowledge of fluid and gas mechanics in various engineering and scientific institutions, such as aviation and aerospace technology, marine and river technology, energy, ecology, meteorology and etc.	5			v	v						

11.	Fundamentals of physical optics	The purpose of the discipline "Fundamentals of Physical Optics" is to acquaint students with the basics of optics, its phenomena and laws, and understand their physical nature. As well as the ability to use fundamental laws, the theory of classical and quantum optics. The course content fully reveals the laws of geometrical optics, the phenomena of interference, diffraction, polarization, dispersion of light, thermal radiation and quantum optics. This course provides an introduction to experimental facts and a generalization of the physical laws of Optics.	5			v	v						
12.	Engineering and computer graphics		5	v				v					
13.	Introduction to modern solid state physics	The aim of the discipline is to develop in students a deep understanding of the basic principles and laws that underlie modern solid state physics, and their application to solve practical problems, such as developing new materials, improving the properties of existing materials, creating new technologies and applications. As a result of studying this discipline, students can also develop skills in analysis, modeling and experimental research in the field of solid state physics.	5			v		v					
14.	Fundamentals of Nanotechnology	The main of the discipline "Fundamentals of Nanotechnology" is to teach students basic knowledge about nanotechnologies, their properties and methods of obtaining, as well as the use of nanomaterials in various fields. It covers the following topics: introduction to nanotechnology, properties of nanomaterials, methods for obtaining nanomaterials, characterization of nanomaterials (SEM, TEM, AFM methods and others) and applications of nanotechnology (in electronics, medicine, space technology, energy and other fields).	5			v		v					

15.	Nuclear Physics	In the discipline "Nuclear Physics" the main provisions of the physics of the atomic nucleus and elementary particles are given. Nuclear forces and nuclear models are considered. Special attention is paid to the types of radioactivity and the laws of radioactive decay. The main types of nuclear reactions and fission chain reaction are disclosed. Modern achievements in the field of nuclear physics and the basic principles of nuclear energy are considered. The fusion reaction of atomic nuclei and the problem of controlled thermonuclear reactions are described.	6			v	v						
16.	Technical thermodynamics	The purpose of mastering the discipline to acquisition the basic competencies in the field of technical thermodynamics, which are necessary for the successful work of a nuclear power engineer. As a result of mastering the discipline, the student must: Know: • basic laws of thermodynamics; • methods of obtaining, converting, transferring and using heat; • principles of construction of thermodynamic cycles. Be able to: carry out thermodynamic analysis of heat engine cycles in order to optimize their performance and to maximize efficiency.	5			v	v						
17.	Current Problems of Nanoelectronics	The purpose of the discipline "Current Problems of Nanoelectronics" is to provide theoretical and practical training to students for solving technical and scientific problems in the manufacture and use of devices based on nanostructured materials. Research in the field of nanoelectronics is devoted to the development of technologies for obtaining new materials for main oil pipelines, aviation, space, atomic and nuclear	5					v				v	

		technology, and for many other applications that can operate in extreme conditions.											
18.	Theory of Nuclear Reactions	The discipline allows you to master the fundamental concepts of the theory of nuclear reactions In the process of studying the discipline, students will get acquainted with the basic principles and mathematical models of nuclear reactions, as well as learn about the limits of their applicability. The discipline consistently considers various approaches to describing the mechanisms of nuclear reactions, which allows students to acquire not only extensive theoretical knowledge, but also to form the ability to solve applied problems related to the theory of nuclear reactions.	5				v					v	
Cycle of basic disciplines Component of choice													
19.	Numerical methods in nuclear power engineering. Part 1	The aim of the discipline is to teach students specific modeling methods and tools used in nuclear energy, as well as to acquire basic programming languages necessary for working in this field. During the course, students will become familiar with programming languages, mathematical libraries, data structures and types, conditional constructs and loops, user-defined functions, as well as reading and writing data to a file.	5				v	v				v	
20.	Computer methods in nuclear power engineering. Part 1	The aim of the discipline is to study the methods of computer modeling of processes in nuclear energy using software tools, as well as programming in Python and MATLAB. Within the framework of the course, students will learn to work with computer methods, model nuclear processes and analyze data, which will be useful for their further work in the field of nuclear energy and other areas where computer modeling methods are used.	5				v	v				v	
21.	Numerical methods in nuclear power	The aim of the discipline is to develop students' skills in using numerical methods to solve problems in the	5				v	v				v	

	engineering. Part 2	field of nuclear energy. After studying this discipline, students will be able to demonstrate knowledge and apply the principles of numerical methods, use the method of computational experiment, work with the Monte Carlo method, and analyze results obtained using numerical methods in the field of nuclear energy. They will also learn the basics of modeling thermal processes in nuclear reactors.											
22.	Computer methods in nuclear power engineering. Part 2	The aim of the discipline is to teach students modern computer methods used in nuclear energy. Students will study various modeling methods for nuclear systems and processes, software for analyzing nuclear safety, data analysis methods, and programming in Python. Upon completion of the course, students should be able to apply this knowledge and skills to work with nuclear materials to enhance efficiency and safety.	5				v	v				v	
23.	Physical and chemical properties of functional materials	The discipline "Physical and chemical properties of functional materials" is devoted to studying the physical and chemical properties of functional materials that are used as a working element or part in a technical device, or structure. Functional materials, which can include composites, alloys, polymeric and other compounds, are used in a different areas of modern life such as micro- and nanoelectronics, alternative energy sources, space research, and others.	5					v	v			v	
24.	Basics of Financial Literacy	Purpose: acquiring knowledge and skills in the field of personal finance management, including budget planning, use of financial instruments, taxation and investments to ensure effective management and increase of own funds. Contents: as part of the course, students will master the basics of financial management, learn how to create a budget, use various financial products, plan and pay taxes. They will also	5	v	v					v			

		gain practical skills in analyzing financial information and choosing investment strategies.											
25.	Fundamentals of Artificial Intelligence	The purpose of the course is to familiarize students with the basic concepts, methods and technologies in the field of artificial intelligence: machine learning, computer vision, natural language processing, etc. As a result of studying this course, students will gain an understanding of the basic principles of artificial intelligence systems and their role in the modern world. The purpose of this course is to provide an introduction to the basic concepts, methods, and technologies of artificial intelligence, such as machine learning, computer vision, natural language processing, and others. Students will acquire knowledge of the key principles, algorithms and practical applications that underlie the development and use of artificial intelligence in various fields. Upon completion of the course, students achieve the following learning outcomes: Know basic machine learning techniques, including supervised, unsupervised and reinforcement learning; be able to apply machine learning methods to solve various problems; have skills in working with various artificial intelligence tools and technologies.	5		v			v					
26.	Study of irradiated materials	The goal of studying this discipline is to provide an understanding of the structure and properties of irradiated materials and to reveal the causes and patterns of changes in the material's macroscopic properties, such as low- and high-temperature embrittlement, swelling, creep, etc. Upon completion of the course, the student will be able to apply the acquired knowledge, skills, and competencies to implement professional activities related to the study of irradiated materials in the atomic industry.	5					v	v			v	

27.	Condensed matter physics		5					v				v	
28.	Physics of semiconductor devices	The main of the discipline "Physics of semiconductor devices" is to study the basic principles of semiconductor physics and their application in electronics. It includes the study of the physical properties of semiconductors such as electrical conductivity, optical properties, and semiconductor crystal structures. In addition, the discipline also covers theoretical and experimental methods for the study of semiconductor materials, as well as the application of semiconductor devices in electronics, such as transistors, diodes, and integrated circuits.	5					v				v	
29.	Fundamentals of sustainable development and ESG projects in Kazakhstan	Purpose: the goal is for students to master the theoretical foundations and practical skills in the field of sustainable development and ESG, as well as to develop an understanding of the role of these aspects in the modern economic and social development of Kazakhstan. Contents: introduces the principles of sustainable development and the implementation of ESG practices in Kazakhstan, includes the study of national and international standards, analysis of successful ESG projects and strategies for their implementation in enterprises and organizations.	5			**v**						**v**	
30.	Modern nuclear technologies	The aim of the discipline is to familiarize students with the principles of nuclear reactor operation and methods of nuclear waste processing. It also develops an understanding of the challenges and issues associated with the use of nuclear technologies, and contributes to the development of comprehensive knowledge and skills in the fields of energy, medicine, and science. The discipline is aimed at ensuring the safety of nuclear energy and minimizing its impact on the environment.	5				v	v					

Cycle of major disciplines University component													
31.	Atomic physics		5			v	v						
32.	Quantum mechanics		5			v	v						
33.	Physics and technology of charged particle accelerators		5							v		v	
34.	Steam turbines Heat power plants and nuclear power plants		5					v			v		v
35.	Experimental methods of nuclear power	The main goal of this discipline is to teach students the skills of designing, conducting and analyzing experiments related to nuclear power in various applications. Questions of the interaction of phonon radiation, heavy charged particles and electrons with matter are considered. Methods for detecting radioactive radiation are presented. Special attention is paid to the types of gas ionization detectors and semiconductor detectors. Methods for statistics of nuclear radiation and scintillation spectrometry of gamma radiation are described.	5				v	v	v			v	
36.	Nuclear, thermal and renewable energy	The discipline is aimed at building competencies in the field of various types of energy, including nuclear, thermal and renewable, and their role in modern and future energy systems. Students study the basics of production, distribution and use of energy, as well as aspects of environmental safety and energy efficiency. The learning process uses active methods, such as the case method, discussion of problematic situations, excursions to the industrial facilities and working with simulators.	4				v					v	v
37.	Methods for calculating the physical characteristics of	The course introduces students to the physics of the processes going on in nuclear reactors and basic methods of simulating these processes on a computer.	5				v	v				v	

	reactors	The focus of the discussion is on the theory of criticality, the simplest equations of reactor kinetics and dynamics, and the applicability of the diffusion approximation. Computation of neutron transport is presented in the context of the Monte Carlo method and its main algorithms. The development of the discipline makes provision for active use of multimedia presentations, and independent coding of computer programs simulating physical processes in reactors.												
38.	Nuclear reactors and nuclear power plants	The purpose of the study is to develop students' deep knowledge in the field of nuclear energy, understanding the basic principles of the operation of nuclear reactors and the use of nuclear energy in the production of electricity, as well as mastering the skills of designing, operating and managing nuclear reactors in compliance with the requirements of radiation safety and environmental protection. Active learning methods include group projects, practical exercises and computer simulations.	4				v	v	v			v	
39.	Plasma physics	The purpose of studying the discipline is the basic principles and phenomena of plasma, its formation, properties, interaction with an electromagnetic field and other particles, as well as application in science and technology (astrophysics, thermonuclear energy, plasma technologies, ion-plasma engines, etc.). Students learn the basic concepts and theories of plasma physics, such as electrodynamics, thermodynamics, plasma waves, interaction with surfaces, diagnostics, and other aspects.	4							v		v	
40.	Dosimetry and radiation protection	Dosimetry is the basis for developing radiation safety measures and protection in case of accidents at radiation (nuclear) hazardous facilities, at nuclear power plants (AE). Basic concepts and units in radiation safety. Radiation protection and the safety of	4						v			v	

		personnel, the public and the environment. Devices for dosimetric control of external and internal exposure. Regulation of human exposure. Safety regulations. Nuclear law. Security principles.											
Cycle of major disciplines Component of choice													
41.	Physics of Uranium	The discipline “Physics of Uranium” is aimed at studying the physical and chemical properties of uranium and uranium compounds. The purpose of the discipline is to obtain basic knowledge about the nature, production, enrichment, and use of uranium, uranium oxides, uranium nitrides and other uranium compounds. In the process of mastering the discipline, students will acquire the skills to solve practical problems in the processing of uranium ores and the processing of radioactive waste from nuclear fuel.	4				v		v	v			
42.	Technology of production of uranium	The discipline "Technology of production of uranium" allows students to master the methods of obtaining uranium, its main alloys and compounds. In the process of studying this discipline, students will become familiar with the methods of extracting uranium, methods of purifying uranium, the basics of the production of fuel elements and fuel assemblies. Particular attention in the content of the discipline is given to the formation of students' skills in the safe handling of uranium and its compounds, as well as the disposal of radioactive waste from nuclear energy.	4				v		v	v			
43.	Laser power plants and the interaction of radiation with matter	The goal of studying this discipline is to provide students with fundamental knowledge and theoretical foundations in the field of high-power lasers, laser thermonuclear fusion, plasma physics, and their applications. Students studying this discipline can acquire the knowledge and skills necessary to work with laser systems, as well as understanding the	5							v		v	

		interaction of laser radiation with matter, which can be applied in various industrial, scientific and medical fields.											
44.	Nuclear safety and nuclear waste storage technology	The main goal of this discipline is to develop students' knowledge about the main technological sources of radioactive waste for the effective management of nuclear materials and waste. The main objectives of this course are: Study of methods of collection, storage, transportation, processing and disposal of radioactive waste; Studying methods of maintaining the natural background radiation in accordance with the principles of rationing, skills of working with regulatory documentation governing radiation safety.	5				v		v			v	v
45.	Microprocessor relay protection	The objectives of studying the discipline is acquisition by undergraduates of the necessary knowledge about the structural diagram and basic elements of digital devices for relay protection and automation, design features and functionality of these devices; the acquisition of skills in calculating the parameters and characteristics of operation, testing and diagnostics of microprocessor relay protection devices	5								v		
46.	Legal regulation of intellectual property	Purpose: the goal is to form a holistic understanding of the system of legal regulation of intellectual property, including basic principles, mechanisms for protecting intellectual property rights and features of their implementation. Contents: The discipline covers the basics of IP law, including copyright, patents, trademarks, and industrial designs. Students learn how to protect and manage intellectual property rights, and consider legal disputes and methods for resolving them.	5	v	v								
47.	Interactions of charged particles with matter	Physical nature of charged particles. Classification of sources of charged particles. Technological and	5							v		v	

		generating sources of ionizing radiation. In the interaction of nuclear radiation and heavy ions with matter. Energy transfer by charged particles and processes leading to attenuation. Weakening of electron flows when passing through matter. Interaction of γ-radiation with matter. Interaction of neutrons with matter. Changes in the structure and properties of living and non-living matter. Problem solving.											
48.	Nuclear technologies and their applications	The purpose of the discipline is to acquire knowledge about the basic properties of atomic nuclei, nuclear forces, elementary particles, and the ability to take advantage of nuclear science and technology to improve the lives of its citizens and protect the environment. The main objectives of this course are: Exploring innovative ways to use nuclear science and technology in medicine, to combat climate change, to increase food production, and to reduce the negative effects of fertilizers.	5				v	v				v	
49.	Actual problems of Nuclear energy in the Republic of Kazakhstan	The main purpose of the discipline "Actual problems of Nuclear energy in the Republic of Kazakhstan" is to form students' understanding of the current state of nuclear energy in Kazakhstan, talking about the problems and main directions of development in this area. The discipline examines the history of the formation and development of nuclear energy in the Republic of Kazakhstan and its current state, approaches and ways of solving urgent problems, the main problems of ensuring environmental and geopolitical security, the real position of the country in the world markets of nuclear resources, discover new methods of research in this important area of Physics.	4				v		v	v			v

50.	Prospects for the development of nuclear energy Kazakhstan	The discipline includes the study of technical, economic, environmental and social aspects of the use of atomic energy in Kazakhstan, the analysis of infrastructure, legislation and innovations in this area. Students study the economic, environmental and social factors influencing the development of nuclear energy in Kazakhstan. Active learning methods include completing research assignments, the implementation of scientific research assignment, creating and presenting projects, and interacting with industry experts.	4				v		v	v			v
51.	Relay protection and automation of power systems	Expansion of views on the possibilities of relay protection; Fixing and concretization of theoretical material concerning the principles of operation and the device of relay protection, their basic properties, application techniques; Gaining the skills of calculating the parameters necessary for configuring relay protection; The correct choice of methods and means of relay protection; Evaluation of the efficiency and reliability of the selected relay protection.	4				v		v	v			v