NON-PROFIT JOINT STOCK COMPANY "KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I. SATPAYEV"

SATBAYEV UNIVERSITY

Institute of Energy and Mechanical Engineering named after A. Burkitbaev
Department of General Physics

EDUCATIONAL PROGRAM
6B07129 - Nuclear Power Engineering

Code and classification of the field of education: **6B07 Engineering, manufacturing and construction industries**
Code and classification of training directions: **6B071 Engineering and Engineering Studies**
Group of educational programs: **B062 Electrotechnics and Power Engineering**
Level based on NQF: **6**
Level based on IQF: **6**
Study period: **4 years**
Amount of credits: **240 credits**

Almaty 2025

Educational program 6B07129 "Nuclear Power Engineering" was approved by the Council of Ministers meeting of the Academic Council of KazNRTU named after K.I. Satpayev.

Minutes No. 12 dated April 22, 2024

was reviewed and recommended for approval at the meeting of K.I. Satbayev KazNRTU Educational and Methodological Council

Minutes No. 6 of April 19, 2024

Educational program 6B07129 "Nuclear Power Engineering"
code and name of educational program
was developed by Academic committee based on direction « Engineering and Engineering Studies »

Full name	Degree/ academic title	Position	Place of work	Signature
Chairman of the Academic Committee:				
Aidos Bakytzhanovich Lesbayev	PhD	Associate Professor	Department of General Physics, IEaM	
Teaching staff:				
Yerik Ongarovich Shalenov	PhD	Associate Professor	Department of General Physics	
Employers:				
Nurzhan Orynbasarovich Saduev	Doctor of Philosophy (PhD)	Deputy General Director for Scientific Work	Institute of Nuclear Physics	
Students				
Ermekov Ali Aigalievich	2nd year student		NJSC KazNRTU named after K.I. Satpayev	

Table of contents

List of abbreviations and designations

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

1. Description of the educational program

This educational program is aimed at meeting the growing need of the Republic of Kazakhstan for young specialists in connection with the construction of NPPs. The educational program is focused on achieving the goal of sustainable development in the field of nuclear energy - safety of NPP reactor installations, improvement of environmental ecology, improvement of the quality of life of mankind, etc.

The field of professional activity

Graduates trained in nuclear power engineering will be involved in the design and operation of nuclear reactors, which contributes to the implementation of safe energy technologies. Their professional activity is able to reduce negative environmental impact and increase safety in the use of nuclear energy, which fulfils the SDGs on "Sustainable Cities and Communities" and "Climate Action".

Main objects of graduates: nuclear power plants, reactors and nuclear installations as objects of human activity related to their design, construction and operation.

Bachelors, who have obtained the specialty "Nuclear Power Engineering", can perform the following types of professional activities:

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

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

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

– calculation and design, associated with mathematical modelling and calculations of nuclear reactor characteristics;

– experimental and research, including scientific research in the field of nuclear energy.

Functions of professional activity of graduates of the specialty of nuclear power engineering:

– design of nuclear reactors and nuclear power generation systems;

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

– assessing the safety of nuclear installations and power generation systems, and developing measures to improve safety;

– organization and management of production process in nuclear power engineering;

– conducting research in the field of nuclear physics and nuclear power technologies;

– 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 power;

– consulting and expertise in the field of nuclear energy;

– working with regulatory and normative bodies in the field of nuclear energy;
– development and introduction 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 design of safety and control systems;
– study of physical and technological properties of materials used in nuclear power engineering;
– development of training programs and methods for nuclear facility personnel;
– risk assessment and development of measures to prevent accidents at nuclear facilities;
– development and introduction of new technologies in nuclear power, for example, to improve the performance of nuclear reactors;
– development and implementation of radioactive waste treatment and utilization systems;
– organization and coordination of work on construction and operation of nuclear facilities;
– work in research centers engaged in the development of new technologies and materials for nuclear power;
– work in state bodies involved in regulating nuclear power and controlling the safety of nuclear facilities;
– advising companies and organizations that use nuclear power in their activities.

Areas of professional activity of the graduate of this program specialty:
– design, development and operation of nuclear reactors and other nuclear facilities;
– handling nuclear fuel and materials, including their production, processing, storage and transport;
– 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 work on construction and modernization of nuclear facilities;
– assessment of environmental and socio-economic consequences of nuclear energy use;
– working in research and educational institutions and also in government and private organizations related to nuclear power;
– participation in international nuclear power projects and interaction with international organizations in the field of nuclear power.

The content of professional activity in the field of nuclear power engineering includes a set of means, methods and technologies required to carry out design, production and technological; organizational, economic and managerial activities.

as well as experimental research in the field of nuclear power engineering. To ensure the production of competitive products in the field of nuclear power engineering, modern methods of design, calculation and design work and technical analysis are used, as well as innovative technologies related to the use of nuclear energy.

The educational program involves students' participation in international projects, which not only enriches their experience, but also contributes to the implementation of the world's best practices in the field of nuclear energy. This is fully in line with the SDG "Partnership for the Goals", which emphasizes the importance of international cooperation in achieving sustainable development.

The program includes areas related to the assessment of environmental and socio-economic impacts, the development of accident prevention measures and the implementation of occupational health and safety systems, which is in line with the Health and Wellbeing SDGs.

The program embeds core competencies such as knowledge of physics, mathematics, nuclear systems design and operation that not only contribute to the personal development of students but also support the global goals of sustainable development. The ability to research and develop new technologies entrenches the pursuit of innovation and sustainable production, which is linked to the SDG "Innovation and Infrastructure".

Requirements for the key competences of a bachelor's degree.

A bachelor's degree should:

- have knowledge in physics, mathematics, thermodynamics, mechanics and other scientific disciplines related to nuclear power engineering;
- understand the fundamentals of nuclear physics and reactor technology and be able to apply them to solve problems in the field of nuclear power engineering;
- be familiar with the principles and methods of nuclear fuel handling, reactor control and radiation protection;
- have knowledge in the design, operation and repair of nuclear reactors and other nuclear power related systems;
- be able to work with various software products used in the nuclear power industry, such as nuclear modelling software reactors and data processing software;
- be familiar with the principles of risk management and safety in the nuclear power industry and be able to apply them in practice;
- have skills of communication and co-operation with colleagues, including specialists from other fields;
- be able to work under 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 power and be able to work in a team to achieve common goals.

The combination of the above aspects makes this educational program not only relevant for the development of nuclear energy in Kazakhstan, but also significant in the context of the implementation of the global UN Sustainable Development Goals.

Graduates of this specialty will be ready to implement technologies that reduce environmental risks and contribute to strengthening the sustainability of society.

2. Purpose and objectives of the educational program:

EP Goal:

The goal of training specialists in the field of nuclear energy is to develop highly qualified and competitive professionals who are ready to work in industrial enterprises, research centers, and laboratories. The educational process aims to provide students with fundamental knowledge and practical skills in nuclear physics, engineering, and technology, which is directly related to SDG 4 — Quality Education, striving to ensure inclusive and equitable education and promote lifelong learning opportunities for all.

The program is aimed at training specialists capable of developing and implementing environmentally clean technologies in the field of nuclear energy, which, in turn, contributes to achieving several other SDGs, including SDG 6 — Clean Water and Sanitation, SDG 7 — Affordable and Clean Energy, and SDG 12 — Responsible Consumption and Production. These goals involve the use of innovative approaches in energy production, minimizing environmental impact, and ensuring sustainable and responsible use of natural resources.

EP Objectives:

Training students in the field of nuclear energy includes several key aspects that are directly related to the United Nations Sustainable Development Goals (SDGs).

- One of the main directions is teaching students the fundamentals of nuclear physics, including the physics of atomic nuclei, elementary particles, and relativistic nuclear physics. This forms the foundation for training highly qualified specialists, which aligns with **SDG 9 (Industry, Innovation, and Infrastructure)**, aimed at developing sustainable and innovative infrastructure, as well as **SDG 13 (Climate Action)**, since knowledge of modern nuclear energy technologies contributes to the development of safer and more effective solutions for combating climate change.
- An important element of the educational process is teaching methods for conducting project and survey research and preparing scientific projects in the field of nuclear energy. These skills contribute to achieving **SDG 4 (Quality Education)**, ensuring access to quality education and learning resources that are necessary for a successful career in a rapidly evolving world.
- The program is also focused on the development of personal qualities in students, such as the ability to learn throughout life and the desire for professional and personal growth. This corresponds to **SDG 8 (Decent Work and Economic Growth)**, aimed at creating conditions for sustainable economic growth and providing decent jobs, as well as **SDG 5 (Gender Equality)**, as the development of such qualities promotes social justice and equal opportunities for all.

- Teaching students the skills to navigate modern information flows and adapt to the rapidly changing conditions in the nuclear energy sector is also of key importance. This contributes to achieving **SDG 4 (Quality Education)**, providing students with the necessary knowledge to effectively interact with new information technologies, as well as **SDG 17 (Partnerships for the Goals)**, since the successful use of information and technologies is crucial for international collaboration and the implementation of joint projects in the field of sustainable development.

The objectives of the program are closely linked to the United Nations Sustainable Development Goals and are aimed at training specialists who will not only possess the necessary knowledge and skills but will also become active participants in achieving a sustainable future for society and the planet.

3. Requirements for evaluating the educational program learning outcomes

In order to successfully graduate and receive a bachelor's degree, it is necessary to fulfill the generally binding standard requirements, which include the completion of at least 240 credits of theoretical study and the preparation of a final thesis. These credits must be earned by taking all courses included in the undergraduate curriculum. In addition, it is necessary to successfully pass all examinations and defend the thesis in accordance with the established requirements. Upon fulfillment of all these conditions, the student will be awarded a Bachelor's degree.

Passport of educational program

4.1 General information

№	Field name	Note
1	Code and classification of the field of education	6B07 Engineering, manufacturing and construction industries
2	Code and classification of training directions	6B071 Engineering and Engineering Science
3	Educational program group	B062 Electrical engineering and Power engineering
4	Educational program name	6B07129 - Nuclear Power Engineering
5	Short description of educational program	Graduates of the specialty "Nuclear Power Engineering" may be engaged in the design, modelling, maintenance and operation of nuclear installations, and in conducting research in this field. 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. Key skills of graduates include knowledge of nuclear reactor physics, mathematical modelling, working with automated control systems and safety monitoring systems, teamwork and responsible decision-making.

6	Purpose of the EP	The goal of training specialists in the field of nuclear energy is to develop highly qualified and competitive professionals who are ready to work in industrial enterprises, research centers, and laboratories. The educational process aims to provide students with fundamental knowledge and practical skills in nuclear physics, engineering, and technology, which is directly related to SDG 4 — Quality Education, striving to ensure inclusive and equitable education and promote lifelong learning opportunities for all. The program is aimed at training specialists capable of developing and implementing environmentally clean technologies in the field of nuclear energy, which, in turn, contributes to achieving several other SDGs, including SDG 6 — Clean Water and Sanitation, SDG 7 — Affordable and Clean Energy, and SDG 12 — Responsible Consumption and Production. These goals involve the use of innovative approaches in energy production, minimizing environmental impact, and ensuring sustainable and responsible use of natural resources.
7	Type of EP	New
8	The level based on NQF	6
9	The level based on IQF	6
10	Distinctive features of EP	Nuclear engineering students will receive a broad training in mathematics, mechanics, physics and information technology. They will learn methods of analytical, experimental and numerical modelling, as well as the development of computer models of complex mechanical and physical processes. Graduates will be able to apply theoretical and experimental methods to investigate problems in mechanics, as well as mathematical and computer modelling to solve engineering problems. They will also be able to develop models of complex processes and create computer codes to solve them. This training is essential for work in the field of nuclear power, where mathematical modelling and computer technology are key to the design, development and operation of nuclear reactors and other devices and systems.
11	List of competencies of educational program	**General competences** – Proficiency in Kazakh, Russian and English for fluent communication and work with scientific literature on nuclear power engineering. – Critical Systems Thinking, Transdisciplinarity and cross-functionality. – Possession of ICT competences and ability to develop software. – Skills of independent learning and deepening of knowledge, systematic thinking and own judgement. – Tolerance towards other nationalities, races, religions and cultures, and the ability to engage in intercultural dialogue. – Communication and teamwork skills. – Willingness to work in a highly uncertain and fast paced environment and to work with customer demands. – Broad social, political and professional outlook, ability to use data from various sources and to analyze and evaluate historical facts and events.

		– Knowledge of the basics of entrepreneurship and business economics, readiness for social mobility. – Drawing up technical and production documentation and performing work on metrology, standardization and preparation for certification of technical means, systems, processes, equipment and materials. – Analyzing equipment processes to ensure they operate efficiently and safely. – Ensuring optimal operating modes of the main components of a nuclear reactor. **Professional competences** – 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 engineering and design of various nuclear systems. – Ability to develop new designs and devices, including nuclear reactors and nuclear fuel related systems. – Ability to operate high-tech laboratory and research equipment used in the nuclear power industry. – Mastery of algorithmic languages and programming technology, as well as skills in computer modelling and research of complex physical and nuclear processes. – Possession of skills to work as a designer in the field of nuclear energy, including the design of nuclear facilities and equipment, as well as work with nuclear fuel and radiation materials.
12	Learning outcomes of educational program	LR1 apply basic knowledge of fundamental disciplines of mathematics and digital technologies in design and production preparation in the field of nuclear power engineering. LR2 apply knowledge of economic laws, occupational health and safety, ecology, rules of moral development, culture of academic integrity at a professional level, taking into account the peculiarities of working with nuclear materials and ensuring safety at nuclear facilities. LR3 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, promote the development of innovative infrastructure, and support scientific research that leads to the creation of sustainable and environmentally safe solutions. (SDG 9: Industry, Innovation, and Infrastructure). LR4 apply the basic laws of nature and principles of natural sciences, use mathematical methods and electrical engineering calculations to solve problems of varying complexity in the field of nuclear physics and nuclear energy, and apply the principles of natural sciences for the efficient use of resources and waste management in nuclear energy. (SDG 12: Responsible Consumption and Production). LR5 use experimental, theoretical and computer-aided research and

		design methods to determine the radioactive and chemical composition, structure and properties of materials used in nuclear power engineering. LR6 analyze ways to ensure nuclear and radiation safety, security and control of nuclear materials, technical and environmental safety of production at the work site. LR7 calculate nuclear reactions, perform nuclear decays, produce uranium pellets, study plasma and investigate the interaction of radiation with matter in the fundamental processes of nuclear physics, nuclear power, fusion and radioecology. LR8 diagnose and control the operation of relay protection and electrical automation devices, control and measuring devices, microprocessor devices in electrical systems and networks, as well as design relay protection and automation of electrical stations and substations, with skills in working with digital technology and microprocessor systems. LR9 analyze the various methods of using beam-plasma, nuclear power, laser, X-ray and neutron beams in radiation materials science and nuclear physics. LR10 analyze different types of modern nuclear power plants, identify their advantages and disadvantages, make a comparative review of various types of reactors and electronic control systems, assess their efficiency and applicability in current conditions, analyze different types of NPPs with an emphasis on their impact on ecosystems and society, and contribute to making informed decisions in energy policy. (SDG 7: Clean Water and Sanitation).
13	Education form	Full-time
14	Period of training	4 years
15	Amount of credits	240
16	Languages of instruction	Kazakh, Russian, English
17	Academic degree awarded	Bachelor of Engineering and Technology
18	Developer(s) and authors	Associate Professor Shalenov Y.O., Associate Professor K.S. Astemessova

4.2. Relationship between the achievability of the formed learning outcomes based on educational program and academic disciplines

№	Discipline name	Short description of discipline	Amount of credits	Generated learning outcomes (codes)									
				RO1	PO2	PO3	PO4	PO5	RO1	PO7	PO8	PO9	PO10
The General Education Discipline Cycle University component													
8	Fundamentals of anti-corruption culture and law	The course introduces students to the improvement of socio- economic relations in Kazakhstan society and psychological peculiarities of corrupt behavior. Special attention is paid to the formation of anti-corruption culture and legal responsibility for corrupt acts in various spheres. The purpose of studying the discipline "Fundamentals of Anti-Corruption Culture and Law" is to increase public and individual legal awareness and legal culture of students, as well as to form a system of knowledge and civic position on counteracting corruption as an anti-social phenomenon. Expected results: to realize the values of moral consciousness and follow moral norms in everyday practice; to work on raising the level of moral and legal culture; to use spiritual and moral mechanisms to prevent corruption.	5		v							
9	Fundamentals of economics and entrepreneurship	The discipline studies the basics of economics and entrepreneurship from the point of view of science and law; peculiarities, problematic aspects and development prospects; theory and practices of entrepreneurship as a system of economic and organizational relations of business structures; entrepreneurs' readiness for innovative sensibility. The	5		v							

		discipline reveals the content of entrepreneurial activity, career stages, qualities, competences and responsibilities of an entrepreneur, theoretical and practical business planning and economic expertise of business ideas, as well as risk analysis of innovative development, implementation of new technologies and technological solutions.												
10	Fundamentals of methods scientific research	The purpose of the discipline is to form organizational skills and planning of scientific research, techniques of experimental research, methods of information processing. The discipline Introduces students to the goals, objectives and stages of scientific research. The terms and concepts, methods of performing experiments, mathematical methods of processing research results are considered. The concepts of engineering, laboratory and industrial experiment, bench research. The discipline introduces the basics of the theory of inventive problem solving, algorithmic methods of searching for technical solutions and their optimization. Basic mathematical methods of optimization, application of artificial intelligence capabilities for solving, optimization problems, issues of searching, accumulation and processing of scientific information are covered.	5		V									
11	Ecology and life safety	The discipline studies the tasks of ecology as a science, ecological terms, laws of functioning of natural systems and aspects of environmental safety in labor conditions. Environmental monitoring and management in the field of its safety. Sources of pollution of atmospheric air, surface, underground water, soil and ways of solving environmental problems; life safety in the technosphere; natural and man-caused emergencies.	5		V									

Cycle of basic disciplines University component														
12	Mathematics I	The course designed to study the basic concepts of higher mathematics and its applications. The main provisions of the discipline are used in the study of all general engineering and special disciplines taught by the graduate departments. The course sections include elements of linear algebra and analytical geometry, introduction to analysis, differential calculus of functions of one and several variables. The questions of methods of solving systems of equations, application of vector calculus to solving problems of geometry, mechanics, physics are considered. Analytical geometry in the plane and in space, differential calculus of functions of one variable, derivative and differentials, investigation of the behavior of functions, directional derivative and gradient, extremum of a function of several variables.	5	v										
13	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							
14	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	5			v	v							

		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.												
15	Mathematics II	The discipline is a continuation of Mathematics I. The sections of the course include integral calculus of function of one variable and of several variables, theory of series. How to calculate indefinite integrals, their properties. Definite integrals and their applications. Non-unique integrals. Theory of numerical series, theory of functional series, Taylor and Maclaurin series, application of series to approximate calculations.	5	v										
16	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					
17	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.	5			v	v							

		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.												
18	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							
19	Engineering and computer graphics	The discipline is aimed at studying methods of depicting objects and general rules of drawing, using computer graphics; study of the basic principles and geometric approach of modeling and methodology for developing applications with a graphical interface; developing skills in using graphic systems to develop drawings using 2D and 3D modeling methods.	5	v				v						
20	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						
21	Fundamentals of Nanotechnology	The main of the discipline "Fundamentals of Nanotechnology" is to teach students basic knowledge	5			v		v						

		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).												
22	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.	5			v	v							
23	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	5			v	v							

		efficiency.												
24	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 technology, and for many other applications that can operate in extreme conditions.	5					V				V	
25	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														
26	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	
27	Computer methods in nuclear power	The aim of the discipline is to study the methods of computer modeling of processes in nuclear energy	5				V	V				V	

	engineering. Part 1	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.												
28	Numerical methods in nuclear power engineering. Part 2	The aim of the discipline is to develop students' skills in using numerical methods to solve problems in the 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.	5				V	V				V	
29	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	
30	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,	5					V	V			V	

		alternative energy sources, space research, and others.												
31	Optics of quantum low-dimensional structures	The discipline "Optics of quantum low-dimensional structures" provides theoretical training of students in the field of physics of systems of reduced dimensionality, contributes to the formation of a modern understanding of the main scientific and technical problems and prospects of development of low-dimensional materials, their interaction with related areas. Taking into account the goal 12 - providing rational models of consumption and production. The course deals with the optical properties of low-dimensional structures, as well as the principles of operation of devices and appliances based on nanoscale quantum structures.	5					V	V			V	
32	Research methods of radioactive materials	The discipline introduces students to the basic methods of analysis, control and identification of radioactive materials, including spectrometric, radiometric and dosimetry technologies. Mastering these techniques enables future specialists to work effectively in the field of nuclear research, energy and radiation safety. The discipline contributes to by preparing professionals for the safe and sustainable use of nuclear energy.	5					V	V			V	
33	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	

34	Fundamentals of semiconductor physics	Learning the fundamentals of semiconductor physics and material classification can contribute to the achievement of several UN Sustainable Development Goals (SDGs) in particular: SDG 7: Affordable and clean energy Semiconductor materials are the basis for the development of solar cells and other renewable energy sources. Improving the characteristics of semiconductors will help to increase the efficiency of solar panels and reduce their cost. SDG 9: Industry, innovation and infrastructure The development of new semiconductor technologies is leading to more efficient electronic devices, which is fueling industrial innovation. Improved materials for electronics are helping to develop quantum technologies, flexible electronics and energy-efficient components. SDG 11: Sustainable cities and human communities The use of semiconductors in intellectual energy management systems, transport and urban infrastructure contributes to sustainable urban development. SDG 12: Responsible consumption and production Material classification enables the development of green semiconductors and the replacement of toxic components in electronics manufacturing. Optimizing the properties of semiconductor materials helps to increase device lifetime and reduce electronic waste. SDG 13: Climate action Semiconductor technologies play a key role in the development of energy-efficient solutions, including sensors for climate monitoring, energy-efficient electronics and renewable energy.	5			V		V				V	

		Thus, the study of semiconductors and materials contributes to the development of advanced technologies that reduce environmental impact and support sustainable development.											
35	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	
36	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	5				V	V					

		solve various problems; have skills in working with various artificial intelligence tools and technologies.											
37	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 specialised disciplines University component													
38	Atomic physics	The discipline "Atomic Physics" is intended for students of the educational program 6B07129 "Nuclear Power Engineering" and is the basic theoretical and practical basis for the preparation of bachelors under this program. Within the framework of the discipline "Atomic Physics" students study the structure and properties of atoms and atomic processes, the basic concepts of quantum mechanics and quantum mechanical approach to the study of atomic phenomena. Obtaining the quality education and professional skills are the foundation for further application of the theory and experimental methods of atomic physics in practical work, development of depth and detailed research in science, technology and production, which leads to improved socio-economic living conditions, which corresponds to the goals of sustainable development. The discipline "Atomic Physics", along with "Nucleus Physics", logically completes the course of general physics and, at the same time, is the basis for a deeper understanding of subsequent special courses.	6			V	V						

39	Quantum mechanics	Principles of quantum mechanics. Application of the stationary Schrödinger equation to solve some problems. Movement of microparticles in the field of central forces. Hydrogen atom. Quantum statistics. Optical quantum generators. Magnetic characteristics. Elementary particles.	5			v	v						
40	Physics and technology of charged particle accelerators	Basic relations and concepts of accelerator physics. Charged particle in electric and magnetic fields. Classification of accelerators. Charged particle accelerators. Direct acting accelerators. Resonant accelerators. Cyclic accelerators. Induction accelerators. Linear accelerators. Storage installations. Beam diagnostics (shunts, voltage dividers, Faraday cup, delay lines). Accelerators in the national economy, metallurgy, biology.	5							v		v	
41	Steam turbines of TPPs and NPPs	General information about steam turbines of thermal power plants and nuclear power plants. Equations of working fluid flow. Conversion of flow energy taking into account efficiency cars Characteristics of parameters of blade machines. Maximum turbine power. Design diagrams of machines. Strength calculations of main parts and assemblies of steam and gas turbines.	5					v			v		v
42	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	

43	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
44	Methods of calculation of physical characteristics of reactors	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. 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.	5				v	v				v	
45	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	
46	Plasma physics	The purpose of studying the discipline is the basic principles and phenomena of plasma, its formation,	4							v		v	

		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.											
47	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 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.	4						V			V	
Cycle of specialised disciplines Component select														
48	Uranium physics	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			
49	Uranium production technology	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,	4				V		V	V			

		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.												
50	Laser power plants and 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 interaction of laser radiation with matter, which can be applied in various industrial, scientific and medical fields.	5								V		V	
51	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	V
52	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	5									V		

		characteristics of operation, testing and diagnostics of microprocessor relay protection devices.												
53	Relay protection and automation of power systems	Expanding ideas about the capabilities of RH; consolidation and concretization of theoretical material concerning the principles of operation and design of relay protection, their basic properties, methods of application; obtaining skills in calculating the parameters necessary to configure the relay protection; correct choice of methods and means of remediation; assessment of the effectiveness and reliability of the selected RP.	5									V		
54	Interaction of charged particles with matter	Physical nature of charged particles. Classification of sources of charged particles. Technological and 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.	5							V		V		
55	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		
56	Topical problems of	The discipline includes the study of technical,	4				V		V	V				V

	nuclear power in the Republic of Kazakhstan	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.												
57	Prospects for the development of nuclear power in 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