



**Institute** of Energy and Mechanical Engineering named after A.Burkitbayev  
**Department** of Power Engineering

## **EDUCATIONAL PROGRAM**

7M07152 – Digital intelligent sustainable energy systems  
**code and title of the educational program**

Code and classification of the field of education: **7M07 Engineering, manufacturing and construction industries**

Code and classification of training areas: **7M071 Engineering and Engineering affairs**

Group of educational programs: **M099 - Energy and electrical engineering**

NRK Level: **Level 7**

ORC Level: **Level 7**

Duration of study: **2 years**

Volume of credits: **120**

**Almaty 2025**

Educational program **7M07152 «Digital intelligent sustainable energy systems»**  
was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes №10 dated «06» 03 2025.

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

Minutes №3 dated «20» 12 2024.

Educational program **7M07152 «Digital intelligent sustainable energy systems»**  
was developed by Academic committee based on direction «Engineering and  
Engineering»

Full name	Academic degree/ academic title	Post	Place of work	Signature
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## **List of abbreviations and designations**

EP – educational program

BC – basic competencies

PC – professional competencies

LO – learning outcomes

MOOC – massive open online courses

NQF – National Qualifications Framework

IQF – Industry Qualifications Framework

SDG - Sustainable Development Goals

## 1. Description of the educational program

The professional activity of graduates of the program is directed in the field of electric power, thermal power engineering and electrical engineering.

The direction of the specialty and specialization program covers engineering and engineering.

The purpose of the Master's educational program «Digital intelligent sustainable energy systems» is to train scientific and scientific-pedagogical personnel with relevant professional knowledge and practical skills in the field of electric power industry, capable of solving problems of improving society, economy, production, science and education. The Master of Technical Sciences in the educational program «Electrical Engineering and Power Engineering» must have competencies in accordance with the types of professional activity:

- to search, analyze and process information to solve the set scientific and production tasks;
- demonstrate the ability to plan and conduct experiments, interpret the data obtained and draw conclusions;
- use modern information technologies to solve applied problems;
- to choose analytical and numerical methods in the development of mathematical models of electrical installations and systems, technological processes in the electric power industry;
- demonstrate knowledge for the analysis and synthesis of automatic control systems in the electric power industry;
- demonstrate scientific and mathematical principles of reliability of technical systems;
- know the methods of calculation and selection of power energy converters and conversion equipment;
- choose methods for calculating relay protection devices and analyze the reliability of their operation;
- know the methods of calculation and selection of elements of an automated electric drive;
- use modern systems and methods of electromechanical conversion

The educational program "Digital intelligent sustainable energy systems" provides training for masters in the following activities: Design and engineering activities

- the ability to compose and develop various simulation models and electrical circuits;
- knowledge to carry out technological and electric power calculations, to choose electrical and electromechanical equipment.

Design and technological activities

- the ability to justify the effective operating parameters and indicators of the electric power system;

- knowledge to develop energy-efficient, resource-saving technologies and measures to protect the environment;
- skills to make a business plan for a technological project.

#### Research activities

- the ability to conduct a literary and patent search;
- ability to plan and conduct research; - the ability to analyze and summarize the results of the study;
- skills to make reports and conclusions, publish research results;

#### Organizational and managerial activities

- the ability to organize the activities of the team, make work plans and set tasks;
- the ability to carry out activities for the organization of production, develop and compile the necessary documentation;
- ability to solve logistical issues and control the execution of tasks.

## 2. The purpose and objectives of the educational program

**The purpose of** the Master's educational program «Digital intelligent sustainable energy systems» is to train scientific and scientific-pedagogical personnel with relevant professional knowledge and practical skills in the field of electric power industry, capable of solving problems of improving society, economy, production, science and education.

SDG 4 Quality education - The program develops competencies in digital and intelligent systems, trains researchers and teachers of a new generation.

SDG 7 Low-cost and clean energy - The program is aimed at developing technologies for integrating renewable energy sources and improving the efficiency of energy systems.

SDG 9 Industrialization, innovation and infrastructure - Focuses on the introduction of digital, cyber-physical and IoT technologies in the electric power industry, which contributes to the development of innovative infrastructure.

SDG 11 Sustainable cities and human settlements - Smart energy systems create the foundation for smart and sustainable cities.

SDG 12 Responsible consumption and production - Digitalization and intelligent management contribute to optimal energy use and loss reduction.

SDG 13 Combating climate change - Digital solutions help reduce emissions, optimize energy consumption, and ensure energy resilience to climate risks.

SDG 16 Peace, Justice, and Effective Institutions - The program builds ethics, leadership, and academic integrity, which promotes responsible governance and decision-making.

SDG 17 Partnership for Sustainable Development focuses on international cooperation, academic mobility, and interdisciplinary projects.

**Tasks of the EP:** Based on the achievements of modern science, technology and production, to give knowledge and skills in the field of: - production of electric energy and substations; - electric power networks and systems; - power supply of enterprises; - automated electric drive; - relay protection and automation of electric power systems; - renewable energy. In case of successful completion of the full Master's degree course, the graduate is awarded the academic degree "Digital intelligent sustainable energy systems". The Master's degree program "Electrical Engineering and Power Engineering" differs from the existing educational program in the specialty 6M071800 – "Electric Power Engineering" by updating the internal content of the disciplines. The Master's degree program provides for further deepening of the competencies acquired in the bachelor's degree. In this connection, modern innovative disciplines have been introduced into the program:

- energy management system according to international standards;
- modern high voltage equipment;
- modeling of elements of electric power systems;
- management of the energy complex and regulation of the energy sector;
- theory and practice of technical experiment in EE;
- digital electric drive control systems;
- emergency and technological automation of power systems; - special and special automatic control systems in EE.

In the process of mastering the educational program, the Master of Technical Sciences in the field of electric power engineering must acquire the following key competencies:

- to search, analyze and process information to solve the set scientific and production tasks;
- demonstrate the ability to plan and conduct experiments, interpret the data obtained and draw conclusions;
- use modern information technologies to solve applied problems;
- to choose analytical and numerical methods in the development of mathematical models of electrical installations and systems, technological processes in the electric power industry;
- demonstrate knowledge for the analysis and synthesis of automatic control systems in the electric power industry;
- demonstrate scientific and mathematical principles of reliability of technical systems;
- know the methods of calculation and selection of power energy converters and conversion equipment;
- choose methods for calculating relay protection devices and analyze the reliability of their operation;
- know develop plans for the organization of innovative activities at the enterprise; - assess innovation and technological risks when introducing new

technologies; - to know the principles of operation and specifics of emergency and technological automation of power systems;

- have practical skills in maintenance, repair and diagnostics of industrial digital electric drive control systems;

- demonstrate the ability to choose and use methods and methods of optimizing power grids;

- possess the ability to install, test, adjust and put into operation electric power and electrical equipment;

- organize and carry out the operation, repair and maintenance of industrial electrical installations;

- know the methods of overvoltage protection, insulation testing methods and operating principles of test installations;

- know the types of high-voltage electrical technologies used;

- be able to use methods of modeling electrical installations and electrical systems.

Obr the ability to compose and develop various simulation models and electrical circuits; - knowledge to carry out technological and electric power calculations, to choose electrical and electromechanical equipment;

Design and technological activities - the ability to justify the effective operating parameters and indicators of the electric power system;

- knowledge to develop energy-efficient, resource-saving technologies and measures to protect the environment;

- skills to make a business plan for a technological project;

Research activities - the ability to conduct a literary and patent search;

- ability to plan and conduct research;

- the ability to analyze and summarize the results of the study;

- skills to make reports and conclusions, publish research results;

Organizational and managerial activities

- the ability to organize the activities of the team, make work plans and set tasks;

- the ability to carry out activities for the organization of production, develop and compile the necessary documentation;

- ability to solve logistical issues and control the execution of tasks.

The graduate of this educational program is awarded the academic degree "Master" Master of Technical Sciences in the direction. A graduate who has mastered master's degree programs must have the following general professional competencies:

– the ability to independently acquire, comprehend, structure and use new knowledge and skills in professional activities, develop their innovative abilities;

– the ability to independently formulate research goals, establish the sequence of solving professional tasks;

– the ability to apply in practice the knowledge of fundamental and applied sections of disciplines that determine the orientation (profile) of the master's degree program;

– the ability to professionally choose and creatively use modern scientific and technical equipment to solve scientific and practical problems;

– the ability to critically analyze, present, defend, discuss and disseminate the results of their professional activities; – proficiency in the preparation and execution of scientific and technical documentation, scientific reports, reviews, reports and articles;

– willingness to lead a team in the field of their professional activities, tolerantly perceiving social

A graduate who has mastered the master's degree program must have professional competencies corresponding to the types of professional activities that the master's degree program is focused on: research activity:

- the ability to form diagnostic solutions to professional problems by integrating fundamental sections of sciences and specialized knowledge acquired during the development of the master's degree program;

– the ability to independently conduct scientific experiments and research in the professional field, generalize and analyze experimental information, draw conclusions, formulate conclusions and recommendations;

– the ability to create and explore models of the studied objects based on the use of in-depth theoretical and practical knowledge in the field of production, transmission and consumption of electrical energy; scientific and production activity:

- the ability to

independently carry out production and scientific and production field, laboratory and interpretive work in solving practical problems;

– the ability to professionally operate modern field and laboratory equipment and devices in the field of the master's degree program;

– the ability to use modern methods of processing and interpreting complex information to solve production problems; project activity:

– the ability to independently draw up and submit projects of research and scientific-production works;

– readiness to design complex research and scientific production works in solving professional tasks; organizational and managerial activity: - readiness to use practical skills of organization and management of research and scientific-production works in solving professional tasks;

– readiness for the practical use of normative documents in the planning and organization of scientific and production work; scientific and pedagogical activity:

- ability to conduct seminars, laboratory and practical classes; – the ability to participate in the management of scientific and educational work of students in the field of production, transmission and consumption of electric energy.

When developing a master's degree program, all general cultural and general professional competencies, as well as professional competencies related to those

types of professional activities that the master's program focuses on, are included in the set of required results of mastering the master's program.

Mandatory standard requirements for completing the Master's degree and awarding the academic degree of Master of Technical Sciences: mastering at least 59 academic credits of theoretical training, passing the state exam in the specialty, preparation and defense of the final dissertation work before the SAC. Special requirements for completing a master's degree in this program , the graduate must know:

- methods of construction of modern electric power and electromechanical systems;
- current trends in the development of electrical equipment and electrical installations, technical means and automation systems of electric power facilities;
- standards and industry rules, methodological and regulatory materials accompanying the operation, installation, commissioning and design of electric power systems; be able to:
- develop and research traditional and autonomous electric power systems using modern technical and technological means.

### **3. Requirements for the evaluation of the learning outcomes of the educational program**

The previous level of education of applicants is higher professional education (bachelor's degree). The applicant must have a diploma of the established sample and confirm the level of knowledge of the English language with a certificate or diplomas of the established sample. The procedure for admission of citizens to the magistracy is established in accordance with the "Standard rules for admission to training in educational organizations implementing educational programs of postgraduate education".

The formation of a contingent of undergraduates is carried out by placing a state educational order for the training of scientific and pedagogical personnel, as well as paying for training at the expense of citizens' own funds and other sources. The State provides citizens of the Republic of Kazakhstan with the right to receive free postgraduate education on a competitive basis in accordance with the state educational order, if they receive education of this level for the first time. At the "entrance", a master's student must have everything.

Special requirements for admission to the program apply to graduates of related educational programs: heat power engineering, automation and management.

<b>Code</b>	<b>Type of competence</b>	<b>Description of competence</b>	<b>Competence result</b>	<b>Ответствен-ный</b>
Common (Implies full training with possible additional depending on the level of knowledge)				

G1	Communication	Fluent monolingual oral, written and communication skills - ability of non-fluent communication with a second language - The ability to use communicative	Complete 4-year training with the development of at least 240 academic credits (including 120 contact classroom academic credits) with the possible transfer of credits in the second language where	Department of Kazakh and Russian Language, Department of English
		communication in various situations - there are basics of academic writing in the native language - diagnostic test for language level	students have an advanced level. The language level is determined by passing a diagnostic test	
G2	Mathematical literacy	- Basic mathematical thinking at the communication level - ability to solve situational problems based on the mathematical apparatus of algebra and the principles of mathematical analysis - diagnostic test for mathematical literacy in algebra	Complete 4-year training with the development of at least 240 academic credits (including 120 contact classroom academic credits). With a positive diagnostic test, the level of mathematics is 1, with a negative one – the level of algebra and the beginning of analysis	Mathematical literacy
G3	Basic literacy in natural sciences	- basic understanding of the scientific picture of the world with an understanding of the essence of the basic laws of science - understanding of basic hypotheses, laws, methods, formulation of conclusions and estimation of errors	Complete 4-year training with the development of at least 240 academic credits (including 120 contact classroom academic credits). With a positive diagnostic test, the level of Physics 1, General Chemistry, with a negative – the level of the Beginning of physics and the Basic basics of chemistry	Departments in the areas of natural sciences
<p><b>SPECIFIC</b> (implies reduced training due to credit transfer, depending on the level of knowledge on competencies for graduates of 12-year schools, colleges, universities, including humanitarian and economic areas)</p>				

S1	Communication	<p>- Fluent bilingual oral, written and communication skills - ability of non-fluent communication with a third language - skills of writing text of various styles and genres - skills of deep understanding and interpretation of one's own work of a certain level of complexity (essay) - basic aesthetic and theoretical literacy as a condition for fullfledged perception, interpretation of the original text</p>	Full credit transfer by language (Kazakh and Russian)	Department of Kazakh and Russian Language
S2	Mathematical literacy	<p>- Special mathematical thinking using induction and deduction, generalization and concretization, analysis and synthesis, classification and systematization, abstraction and analogy - the ability to formulate, justify and prove</p>	Transfer of credits in the discipline of Mathematics (Calculus) I	Department of Mathematics
		<p>provisions - application of general mathematical concepts, formulas and extended spatial perception for mathematical problems - complete understanding of the basics of mathematical analysis</p>		

S3	Special literacy in natural sciences (Physics, Chemistry, Biology and Geography)	- A broad scientific perception of the world, assuming an understanding of natural phenomena - critical perception for understanding the phenomena of the surrounding world - cognitive abilities to formulate a scientific understanding of the forms of existence of matter, its interaction in nature	Transfer of credits in Physics I, General Chemistry, General Biology, Introduction to Geology, Introduction to Geodesy; Educational practice, etc.	Departments in the areas of natural sciences
S4	English language	- readiness for further selfstudy in English in various fields - readiness to gain experience in project and research work using English	Transfer of English language credits above academic to professional level (up to 15 credits)	Department of English
S5	Computer skills	- Basic programming skills in one modern language - using software and applications to teach various disciplines	Transfer of credits in the discipline Introduction to information and communication technologies, Information and communication technologies	Department of Software Engineering
S6	Sociohumanitarian competencies and behavior	- understanding and awareness of the responsibility of each citizen for the development of the country and the world - the ability to discuss ethical and moral aspects in society, culture and science	Transfer of credits in the Modern history of Kazakhstan (with the exception of the state exam)	Department of Social Disciplines
		- critical understanding and capacity for polemics for debating on modern scientific hypotheses and theories	Transfer of credits in philosophy and other humanities	
<b>PROFESSIONAL</b>				
(implies reduced training due to credit transfer, depending on the level of knowledge on competencies for graduates of colleges, secondary schools, universities)				

P1	Professional competencies	- critical perception and deep understanding of professional competencies at level 5 or 6 - the ability to discuss and polemize on professional issues within the framework of the mastered program	Transfer of credits in basic professional disciplines, including introduction to the specialty, engineering ethics, technology of robotic production, technological automation facilities, theoretical foundations of electrical engineering, technological measurements and instruments, mathematical foundations of control theory, electronic automation devices.	Graduating Department
P2	General engineering competencies	- basic general engineering skills and knowledge, the ability to solve general engineering tasks and problems - be able to use application software packages for processing experimental data, solving systems of algebraic and differential equations	Transfer of credits in general engineering disciplines (engineering graphics, descriptive geometry, fundamentals of electrical engineering, fundamentals of microelectronics.)	Graduating Department
P3	Engineering and computer competencies	- basic skills of using computer programs and software systems to solve general engineering tasks	Transfer of credits in the discipline of computer graphics, computer modeling and programming in the MatLab environment.	Graduating Department
P4	Socio-economic competencies	- critical understanding and cognitive ability to reason on contemporary social and economic issues - basic understanding of the economic assessment of the objects of study and the profitability of projects.	Transfer of credits in socio-humanitarian and technical-economic disciplines to the credit of the elective cycle	Graduating Department

The university may refuse to transfer credits if the low diagnostic level is confirmed or the final grades for completed disciplines were lower than A and B.

## 4. Passport of the educational program

### 4.1. General information

№	Field name	Note
1	Code and classification of the field of education	7M07 Engineering, manufacturing and construction industries
2	Code and classification of training areas	7M071 Engineering and Engineering affairs
3	Group of educational programs	M099 Energy and electrical engineering
4	Name of the educational program	7M07152 - Digital intelligent sustainable energy systems
5	Brief description of the educational program	<p>The educational program "Digital intelligent sustainable energy systems" provides training for masters in the following activities:</p> <p>Design and engineering activities</p> <ul style="list-style-type: none"> <li>- the ability to compose and develop various simulation models and electrical circuits;</li> <li>- knowledge to carry out technological and electric power calculations, to choose electrical and electromechanical equipment;</li> </ul> <p>Design and technological activities - the ability to justify the effective operating parameters and indicators of the electric power system;</p> <ul style="list-style-type: none"> <li>- knowledge to develop energy-efficient, resource-saving technologies and measures to protect the environment;</li> <li>- skills to make a business plan for a technological project;</li> </ul> <p>Research activities - the ability to conduct a literary and patent search;</p> <ul style="list-style-type: none"> <li>- ability to plan and conduct research;</li> <li>- the ability to analyze and summarize the results of the study;</li> <li>- skills to make reports and conclusions, publish research results;</li> </ul> <p>Organizational and managerial activities - the ability to organize the activities of the team, make work plans and set tasks;</p> <ul style="list-style-type: none"> <li>- the ability to carry out activities for the organization of production, develop and compile the necessary documentation;</li> <li>- ability to solve logistical issues and control the execution of tasks</li> </ul>
6	Purpose of the OP	<p>The purpose of the Master's educational program "Digital intelligent sustainable energy systems" is to train scientific and scientific pedagogical personnel with relevant professional knowledge and practical skills in the field of electric power industry, capable of solving.</p> <p>SDG 4 Quality education - The program develops</p>

		<p>competencies in digital and intelligent systems, trains researchers and teachers of a new generation.</p> <p>SDG 7 Low-cost and clean energy - The program is aimed at developing technologies for integrating renewable energy sources and improving the efficiency of energy systems.</p> <p>SDG 9 Industrialization, innovation and infrastructure - Focuses on the introduction of digital, cyber-physical and IoT technologies in the electric power industry, which contributes to the development of innovative infrastructure.</p> <p>SDG 11 Sustainable cities and human settlements - Smart energy systems create the foundation for smart and sustainable cities.</p> <p>SDG 12 Responsible consumption and production - Digitalization and intelligent management contribute to optimal energy use and loss reduction.</p> <p>SDG 13 Combating climate change - Digital solutions help reduce emissions, optimize energy consumption, and ensure energy resilience to climate risks.</p> <p>SDG 16 Peace, Justice, and Effective Institutions - The program builds ethics, leadership, and academic integrity, which promotes responsible governance and decision-making.</p> <p>SDG 17 Partnership for Sustainable Development focuses on international cooperation, academic mobility, and interdisciplinary projects.</p> <p>problems of improving society, economy, production, science and education.</p>
7	Type of EP	New
8	The level of the NRK	7 level
9	ORC Level	7 level
10	Distinctive features of the EP	No
11	List of competencies of the educational program:	<p><b>B – basic knowledge, skills and abilities</b></p> <p>B1 is capable of philosophical analysis of social phenomena, personality behavior and other phenomena. I am ready to conduct a philosophical assessment of social phenomena;</p> <p>B2 – to know and put into practice the basics of engineering professional ethics;</p> <p>B3 – be able to analyze the current problems of the modern history of Kazakhstan.</p> <p><b>P – professional competencies</b></p> <p>P1 – a wide range of theoretical and practical knowledge in the professional field;</p> <p>P2 –is able to analyze electrical circuit diagrams and wiring diagrams of electric power systems.</p> <p>P3 – ready to install, adjust and operate electromechanical and electrical systems;</p> <p>P4 – ready to participate in the development and design of new facilities of traditional and alternative energy.</p>

		<p><b>O – universal, social and ethical competencies</b></p> <p>O1 – is able to use English fluently as a means of business communication, a source of new knowledge in the field of electrical engineering and energy. I am ready to use English in my professional activity in the field of electric power industry;</p> <p>O2 – is able to speak Kazakh (Russian) fluently as a means of business communication, a source of new knowledge in the field of electrical engineering and energy. I am ready to use Kazakh (Russian) language in my professional activity in the field of electric power industry;</p> <p>O3 – to know and apply in work and life the basics of applied ethics and ethics of business communication;</p> <p>O4 – know and apply the basic concepts of professional ethics;</p> <p>O5 – to know and solve the problems of human influence on the environment.</p> <p><b>C – special and managerial competencies</b></p> <p>C1– independent management and control of the processes of labor and educational activities within the framework of the strategy, policy and goals of the organization, discussion of problems, reasoning conclusions and competent information management;</p> <p>C2 –to be a specialist in conducting experimental studies of electric power facilities;</p> <p>C3 –to be a researcher on the study of modern electromechanical and electrical systems;</p>
12	Learning outcomes of the educational program:	<p>PO1 - Possess broad knowledge and skills in the field of renewable energy sources. To know solar, wind, wave, geothermal and hydroelectric power plants, the principles of their operation, operation.</p> <p>PO2 - Possess knowledge of the main pedagogical trends of our time. Be able to conduct a dialogue with students, basic teaching skills, elements of psychology.</p> <p>PO3 - Use a scientific approach to studying the problems of the energy complex. Solve the problems of supplying and providing electricity to remote villages through renewable energy sources.</p> <p>PO4 - Apply knowledge of the main philosophical directions - from ancient Chinese and Greek philosophical schools to modern schools of philosophy, the presence of a technical, philosophical outlook on life in addition to a technical one.</p> <p>PO5 - Demonstrate professional knowledge of the English language, with high technical level negotiation skills using technical terminology.</p> <p>PO6 - Evaluate and develop strategies for managing the energy complex, analyze mechanisms of state regulation in the energy sector, and assess their impact on the development of innovative technologies.</p>

		<p>PO7 - Design and optimize intelligent control systems for power engineering facilities using modern methods of digital modeling, automation, and data analysis.</p> <p>PO8 - Develop new circuit and algorithmic solutions in power electronics, investigate automation and control processes in conversion systems.</p> <p>PO9 - Analyze the operation of power systems and networks, develop and implement digital technologies in relay protection, automatic control, and intelligent power supply.</p> <p>PO10 - Apply microprocessor technologies for the development of intelligent diagnostic and control systems for power equipment, ensuring their reliability and safety.</p> <p>PO11 - Research and apply international and national standards in the energy sector, develop technical solutions considering advanced foreign experience and promising industry trends.</p> <p>PO12 - Design and modernize electric transport systems, automated power supply for industrial enterprises, and develop energy-efficient solutions considering modern environmental requirements.</p>
13	Form of training	Daytime
14	Duration of training	2 years
15	Volume of loans	120
16	Languages of instruction	in Russian, and English.
17	Academic degree awarded	Master of Technical Sciences
18	Developers and authors:	Sarsenbaev Y.A., Khidolda Y.

## 4.2. The relationship between the achievability of the formed learning outcomes according to the educational program and academic disciplines

№	Name of the discipline	Brief description of the discipline	Number of credits	Generated learning outcomes (codes)										
				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
1	Foreign language (professional)	Mastering professional English at an advanced level (for non-linguistic areas). The study of grammatical characteristics of scientific style in its oral and written forms. Professional oral communication in monologue and dialogical form according to the educational program. The ability to demonstrate research results in the form of reports, abstracts, publications and public discussions; interpret and present research results in a foreign language.	3									+		
2	Psychology of management	The course is aimed at mastering the tools of effective employee management, based on knowledge of the psychological mechanisms of the manager's activity. The discipline will help you master the skills of decision-making, creating a favorable psychological climate, motivating employees, setting goals, building a team, and communicating with employees. At the end of the course, undergraduates will learn how to resolve managerial conflicts, create their own image, analyze situations in the field of management, as well as conduct negotiations, be stress-resistant and effective leaders.	3								+	+		
3	History and philosophy of science	Purpose: To explore the history and philosophy of science as a system of concepts of global and Kazakh science. Contents: The subject of philosophy of science, the dynamics of science, the main stages of the historical development of science, the features of classical science, nonclassical and post-nonclassical science, philosophy of mathematics, physics, engineering and technology, the specifics of engineering sciences, ethics of science, social and moral responsibility of scientists and engineers.	3										+	+

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№	Name of the discipline	Brief description of the discipline	Number of credits	Generated learning outcomes (codes)										
				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
4	Pedagogy of Higher Education	The course is aimed at mastering the methodological and theoretical foundations of higher education pedagogy. The discipline will help to master the skills of modern pedagogical technologies, technologies of pedagogical design, organization and control in higher education, skills of communicative competence. At the end of the course, undergraduates will learn how to organize and conduct various forms of training, apply active teaching methods, and select the content of training sessions. To organize the educational process based on the credit technology of education.	3								+		+	
5	Dynamic Symulation in Engineering Systems	Purpose: To teach computer modeling techniques for analyzing complex energy systems. Description: Fundamentals of numerical modeling, software tools (MATLAB, Simulink), examples of modeling power systems. Tasks: To develop complex dynamic models of power systems using MATLAB, Simulink, PSCAD and DIgSILENT PowerFactory. To study the impact of emergency modes on the behavior of power systems and develop strategies to prevent cascading outages. To model transients in systems with different types of generation and energy storage systems.	5	+					+					
6	Integration of RES in traditional energy systems	Purpose: To form knowledge about the methods of integrating renewable energy sources into energy systems. Description: Features of solar, wind and hydroelectric power plants, ways of connecting to the grid, problems and prospects. Objectives: To assess the prospects for the technological development of solar and wind energy, taking into account global trends in the energy sector. To develop methods for stabilizing electricity parameters with a high proportion of renewable energy sources in the energy system. To investigate new circuits of inverter converters to increase the reliability of renewable energy connection to the grid. To analyze the international	5			+					+			

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№	Name of the discipline	Brief description of the discipline	Number of credits	Generated learning outcomes (codes)										
				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
		experience of regulating energy systems with a high proportion of renewable energy sources.												
7	Intellectual property and scientific research	The aim of this course is to provide undergraduates with the knowledge and skills necessary to understand, protect, and manage intellectual property (IP) in the context of scientific research and innovation. The course is aimed at training specialists who are able to work effectively with IP, protect the results of scientific research and apply them in practice.	5							+				
8	Electric Power Quality	The purpose of the discipline is to study the principles and methods of ensuring high-quality electricity in power systems. Description: The discipline examines the parameters of electricity quality, methods of analysis and methods of quality management in power grids. Special attention is paid to the influence of various factors affecting the stability and reliability of power supply, as well as methods for improving quality parameters to ensure efficient operation of electrical equipment.	5		+						+			
9	Project management	Objective: To develop undergraduates' knowledge and project management skills for effective project planning, implementation and completion. Content: Undergraduates will study project management methods and tools, including project plan development, time and resource management, task performance monitoring, risk assessment, and change management. Practical tasks on the application of these methods in real-world project situations are included.	5										+	+
10	Distributed Energy Resources	Purpose: To study the concept of decentralized electricity generation. Description: Types of distributed generation, their advantages, technical and economic aspects. Objectives: To develop mathematical models of the stability of the electric power system under various disturbances, including the massive introduction of renewable energy sources. To study the behavior of synchronous and asynchronous generators in emergency and post-emergency conditions. To evaluate the	5			+					+			

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«KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I.Satbayev»

№	Name of the discipline	Brief description of the discipline	Number of credits	Generated learning outcomes (codes)									
				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
		effectiveness of modern automated frequency and power control systems. To investigate adaptive algorithms for managing energy systems using artificial intelligence and machine learning methods.											
11	Sustainable development strategies	Objective: To train undergraduates in sustainable development strategies to achieve a balance between economic growth, social responsibility and environmental protection. Content: Undergraduates will study the concepts and principles of sustainable development, the development and implementation of sustainable development strategies, assessment of their effectiveness, as well as international standards and best practices. Cases and examples of successful sustainable development strategies are included.	5			+						+	
12	Power System Stability and Control	Sustainability and management of energy systems Objective: To study the dynamics of energy systems, principles of sustainability and management methods. Description: Static and dynamic stability, automatic regulation of power and frequency, the influence of renewable energy sources.	5		+	+							
13	Energy Cyberphysics and IoT in Energy	The purpose of the discipline is to master modern technologies of cyber-physical systems and IoT in the energy sector. Description: The discipline focuses on the application of Internet of Things (IoT) technologies and cyber-physical systems in the energy sector. Undergraduates will study the concepts of digitalization of energy systems, monitoring and management of energy consumption, as well as issues of safety and reliability of energy facilities in the context of digital transformation.	5				+			+			
14	Short circuits in power systems	Purpose: To study the nature of short circuits and methods of their analysis. Description: Classification of short circuits, their consequences, methods of protection, calculation of short-circuit currents. Objectives: To conduct a comprehensive analysis of the nature of short circuits in power	5					+		+			

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				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
		systems, including their dynamic and thermal consequences. To develop mathematical models for calculating short-circuit currents for various configurations of electrical networks. To investigate the effect of short circuits on the reliability and durability of power system equipment, including transformers, power transmission lines, and switchgear. To evaluate the effectiveness of modern selective protection methods, including digital relay systems, high-speed shutdown algorithms, and adaptive emergency management systems. To study short-circuit forecasting methods based on big data analysis and machine learning.											
15	Energy Conversion	Purpose: To form knowledge about the processes of transformation of various forms of energy. Description: Thermodynamic fundamentals, energy converters (electrical, mechanical, thermal), efficiency and losses. Objectives: To analyze the effectiveness of various types of energy converters and their applications. To investigate losses in energy conversion systems and develop methods to minimize them. To evaluate the prospects of multifunctional power plants.	5			+				+			
16	Electrical measurements of non-electrical parameters	Purpose: To teach methods of measuring physical quantities using electrical methods. Description: Sensors of temperature, pressure, flow, vibration and other parameters, the principles of their operation. Objectives: To develop methods for accurate measurements of physical parameters using modern sensors. To study the influence of external factors on measurement accuracy. To explore the possibilities of using quantum sensors in the energy sector.	5						+				+
17	Electromechanical Drive Systems	Purpose: To study the principles of operation and control of electromechanical drives. Description: Theory of electric	5					+					

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				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
		machines, characteristics of electric drives, control systems. Objectives: To study the dynamics of electric drives under variable loads. To develop algorithms for controlling electric drives based on artificial intelligence. To evaluate energy savings in industrial electric drives with the introduction of variable frequency drives.												
18	Computational Intelligence in Power Electronics and Drives	Purpose: To teach the use of AI and machine learning algorithms in electronics. Description: Neural network algorithms, optimization of drive system parameters. Objectives: To study the basics of AI and machine learning for controlling electric drives and power converters. Development of neural network algorithms for optimizing the parameters of drive systems. Intelligent control of power electronics, including adaptive PWM systems and fault prediction. Big Data analysis for diagnostics and predictive maintenance of electric drives. Creation of digital twins and implementation of predictive management to increase energy efficiency.	5				+							
19	Innovative materials and technologies in the field of renewable energy sources	Purpose: Training in advanced renewable energy technologies. Description: Photovoltaic materials, battery technologies, supercapacitors, hydrogen energy. Objectives: To investigate current trends in the development of highly efficient photovoltaic materials, including perovskite and multilayer solar cells. To evaluate the prospects of using solid-state battery technologies and supercapacitors for energy storage systems in the energy sector. To develop innovative solutions to increase the efficiency of power plants based on hydrogen technologies and electrochemical converters. To study the mechanisms of degradation of materials used in solar and wind power installations and propose methods to increase their operational life. To carry out a comparative analysis of technologies for processing and disposing of spent photovoltaic panels and lithium-ion batteries.	5			+								+

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				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
20	Planning and optimization of electric power systems	Goal: To develop strategic planning skills for energy systems. Description: Forecasting models, optimization algorithms, demand and generation management. Objectives: To develop the theoretical foundations of strategic planning of electric power systems in the context of decentralization and integration of renewable energy sources. To investigate methods for optimizing the development of electric power grids, taking into account the projected growth of energy consumption, localization of generating capacities and sustainability of energy systems. To evaluate the effectiveness of intelligent demand management systems, including methods of dynamic pricing, automated load control and digital twin of power systems. To develop mathematical models for predicting energy consumption based on time series, neural network algorithms, and hybrid approaches. To investigate the impact of digitalization, IoT and distributed computing on the processes of dispatching and long-term planning of the electric power industry.	5	+									+	
21	Python Programming and Data Analysis	Goal: To develop programming and data management skills in the energy sector. Description: Python basics, Big Data processing, machine learning. Objectives: To develop algorithms for predicting energy consumption using machine learning, time series, and deep neural networks. To explore the possibilities of using Python to model processes in the electric power industry, including the analysis of operating modes of power systems. To develop big data analysis systems to optimize the operation of power grids and generation. To study the methods of digital monitoring of power systems using computer vision, signal processing and predictive analytics. To develop intelligent energy management systems based on Data Science and artificial intelligence methods.	5				+							+

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				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
22	Project development and management	Purpose: Training in energy project management. Description: Principles of project lifecycle management, methodologies (PMBOK, Agile), risk analysis. Objectives: To study modern project management methodologies (PMBOK, Agile, Lean) in the context of energy project implementation. To develop algorithms for optimizing the life cycle of energy facilities, taking into account the assessment of risks, costs and deadlines for implementation. To explore methods of digital management of energy projects using BIM (Building Information Modeling) and digital twins. To analyze adaptive project management strategies in conditions of uncertainty, including scenario planning and change management. To develop practical recommendations for minimizing risks in the implementation of large-scale energy projects, including technical, economic and environmental aspects.	5										+	+
23	Energy Management Systems (EMS)	Purpose: To form knowledge about intelligent energy management. Description: SCADA systems, control automation, consumption forecasting. Objectives: To study the EMS architecture and methods of automated energy management. Forecasting energy consumption using machine learning and time series. Optimization of load management, implementation of Demand Response and energy-saving technologies. Integration of distributed generation and energy storage in EMS. Ensuring cybersecurity and reliability of energy management systems.	5		+									+
24	Sustainable buildings	Purpose: To study the principles of energy efficient construction. Description: Passive house technologies, intelligent energy consumption systems, building certification. Objectives: To develop comprehensive methods for energy modeling of buildings, taking into account climatic factors, characteristics of building materials and energy consumption systems. To evaluate the effectiveness of modern passive construction technologies, including new generation thermal	5								+			+

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				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
		insulation materials, vacuum panels and phase transition materials. To explore promising intelligent building management (BMS) systems with the integration of IoT technologies, energy consumption forecasting and energy balance management. To analyze the impact of certification systems (OMIR, LEED, BREEAM) on the energy efficiency of buildings and sustainable urban development. To develop recommendations for the implementation of autonomous and hybrid energy solutions in buildings, including the integration of solar panels, heat pumps and energy recovery systems.											
25	Digital Power system protection	Purpose: To study modern methods of protection of power systems. Description: Digital relays, relay protection systems, protection against cyber threats. Objectives: To explore modern cybersecurity methods in the electric power industry, including quantum cryptography, biometric authentication, and blockchain technology. To develop algorithms for detecting anomalies and preventing cyber attacks on critical energy infrastructure facilities. To analyze the vulnerabilities of traditional and intelligent relay protection systems. To investigate methods of protecting power systems from malicious software (SCADA viruses, attacks on IoT devices, DDoS attacks). To develop a strategy for implementing digital solutions to increase the resilience of energy systems to external cyber threats.	5				+						+
26	Energy Startups and entrepreneurship	The purpose of the discipline is to develop the skills of creating and managing startups in the field of energy. Description: The discipline introduces undergraduates to the basics of entrepreneurship and innovative development in the energy sector. Undergraduates will study business models, methods of financing and project management, as well as strategic approaches to the development of energy startups.	5						+				+
27	Energy Efficiency and Sustainable Development	The purpose of the discipline is to study the principles of energy efficiency and their role in ensuring sustainable	5			+						+	

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				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
		development. Description: The course examines methods for improving energy efficiency in various sectors of the economy and their contribution to sustainable development. Undergraduates will study regulatory requirements, energy-saving technologies, as well as the impact of energy efficiency on the economy, ecology, and social sustainability.												

### WORKING CURRICULUM

Academic year	2025-2026 (Spring, Autumn)
Group of educational programs	M099 - "Energy and electrical engineering"
Educational program	7M07152 - "Digital intelligent sustainable energy systems"
The awarded academic degree	Master of Technical Sciences
Form and duration of study	full time (scientific and pedagogical track) - 2 years

Discipline code	Name of disciplines	Block	Cycle	Total ECTS credits	Total hours	lek/lab/pr Contact hours	in hours SIS (including TSIS)	Form of control	Allocation of face-to-face training based on courses and semesters				Prerequisites
									1 course		2 course		
									1 sem	2 sem	3 sem	4 sem	
<b>CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)</b>													
<b>CYCLE OF BASIC DISCIPLINES (BD)</b>													
<b>M-1. Module of basic training (university component)</b>													
HUM212	History and philosophy of science		BD, UC	3	90	15/0/15	60	E	3				
HUM213	Higher school pedagogy		BD, UC	3	90	15/0/15	60	E	3				
LNG213	Foreign language (professional)		BD, UC	3	90	0/0/30	60	E		3			
HUM214	Psychology of management		BD, UC	3	90	15/0/15	60	E		3			
ERG276	Quality of Electrical Energy	1	BD, CCH	5	150	30/0/15	105	E		5			
MNG781	Intellectual property and research	1	BD, CCH	5	150	30/0/15	105	E		5			
ERG296	Power System Stability and Control	1	BD, CCH	5	150	30/0/15	105	E		5			
ERG297	Distributed Energy Resources	2	BD, CCH	5	150	30/0/15	105	E		5			
MNG782	Sustainable development strategies	2	BD, CCH	5	150	30/0/15	105	E		5			
ERG295	Integration of RES in traditional energy systems	2	BD, CCH	5	150	30/0/15	105	E		5			
ERG279	Cyber-Physical Systems and IoT in Energy	1	BD, CCH	5	150	15/30/0	105	E			5		
MNG704	Project Management	1	BD, CCH	5	150	30/0/15	105	E			5		
ERG298	Dynamic Symulation in Engineering Systems	1	BD, CCH	5	150	15/30/0	105	E			5		
<b>M-3. Practice-oriented module</b>													
AAP273	Pedagogical practice		BD, UC	8				R			8		
<b>CYCLE OF PROFILE DISCIPLINES (PD)</b>													
<b>M-2. Module of professional activity in electric engineering (university component, component of choice)</b>													
ERG701	Energy Conversion		PD, UC	5	150	30/15/0	105	E	5				
ERG702	Short Circuits in Power Systems		PD, UC	5	150	30/0/15	105	E	5				
ERG288	Energy Startups and Entrepreneurship	1	PD, CCH	5	150	30/0/15	105	E	5				
ERG703	Sustainable Buildings	1	PD, CCH	5	150	30/0/15	105	E	5				
ERG704	Project development and management	2	PD, CCH	5	150	30/0/15	105	E	5				
ERG705	Digital Power system protection	2	PD, CCH	5	150	30/0/15	105	E	5				

ERG299	Electromechanical Drive Systems		PD, UC	5	150	30/0/15	105	E		5		
ERG700	Electrical Measurement of Non-Electrical Parameters		PD, UC	5	150	30/0/15	105	E		5		
ERG707	Power system planning and optimization	1	PD, CCH	5	150	30/15/0	105	E			5	
ERG709	Innovative Materials and Technologies in Renewable Energy sources	1	PD, CCH	5	150	30/15/0	105	E			5	
ERG708	Energy Management Systems (EMS)	2	PD, CCH	5	150	30/0/15	105	E			5	
ERG292	Energy Efficiency and Sustainable Development	2	PD, CCH	5	150	30/0/15	105	E			5	
ERG706	Computational Intelligence in Power Electronics and Drives	3	PD, CCH	5	150	30/0/15	105	E			5	
CSE200	Python Programming and Data Analysis	3	PD, CCH	5	150	30/0/15	105	E			5	
<b>M-3. Practice-oriented module</b>												
AAP269	Research practice		PD, UC	8				R				8
<b>M-4. Experimental research module</b>												
AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R	4			
AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R		4		
AAP251	Research work of a master's student, including internship and completion of a master's thesis		RWMS	2				R			2	
AAP255	Research work of a master's student, including internship and completion of a master's thesis		RWMS	14				R				14
<b>M-5. Module of final attestation</b>												
ECA212	Registration and protection of the master thesis		FA	8								8
<b>Total based on UNIVERSITY:</b>									30	30	30	30
									<b>60</b>		<b>60</b>	

**Number of credits for the entire period of study**

Cycle code	Cycles of disciplines	Credits			
		Required component (RC)	University component (UC)	Component of choice (CCH)	Total
GED	Cycle of general education disciplines	0	0	0	0
BD	Cycle of basic disciplines	0	20	15	35
PD	Cycle of profile disciplines	0	28	25	53
<b>Total for theoretical training:</b>		<b>0</b>	<b>48</b>	<b>40</b>	<b>88</b>
RWMS	Research Work of Master's Student				24
ERWMS	Experimental Research Work of Master's Student				0
FA	Final attestation				8
<b>TOTAL:</b>					<b>120</b>

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Minutes № 3 dated 20.12.2024

Decision of the Academic Council of the Institute. Minutes № 3 dated 19.12.2024

**Signed:**

Governing Board member - Vice-Rector for Academic Affairs

Uskenbayeva R. K.

**Approved:**

Vice Provost on academic development

Kalpeyeva Z. B.

Head of Department - Department of Educational Program Management and Academic-Methodological Work

Zhumagaliyeva A. S.

Director of the Institute - A.Burkitbaev Institute of Energy and Mechanical Engineering

Yelemesov K. .

Department Chair - Power Engineering

Sarsenbayev Y. .

Representative of the Academic Committee from Employers

Abdykalykov G. Y.

\_\_\_\_Acknowledged\_\_\_\_

