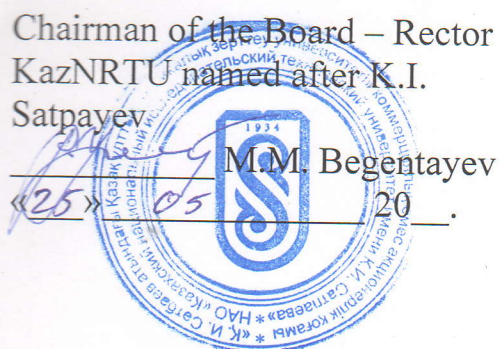


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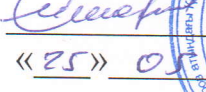
Chairman of the Board – Rector
KazNRTU named after K.I.
Satpayev

 M.M. Begentayev
«25» 05 2025



APPROVED

Chairman of the Board – Rector
KazNMU named after S.D. Asfendiyarov
M.E. Shorarov

 M.E. Shorarov
«25» 05 2025



JOINT EDUCATIONAL PROGRAM
6B07114 «Biomedical Engineering»

**Field of Education Code
and Classification:**

6B07 «Engineering, Manufacturing and
Construction Industries»

**Training Program Code
and Classification:**

6B071 «Engineering and Engineering Affairs»

**Educational Program
Group:**

B063 «Electrical Engineering and Automation»

NQF Level:

IQF Level:

6

Duration of Study:

4 years

Credits:

240 ECTS

Almaty, 2025

The Joint Educational Program 6B07114 – Biomedical Engineering was approved at the meeting of the Academic Council of:

KazNRTU named after K.I. Satpayev, Minutes No. 10 dated "06" 03, 2025

KazNMU named after S.D. Asfendiyarov, Minutes No. ____ dated "____" _____, 20 ____

Reviewed and recommended for approval at the meeting of:

Educational and Methodological Council of KazNRTU named after K.I. Satpayev

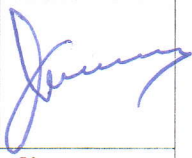
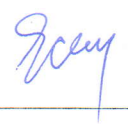
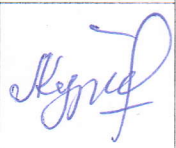
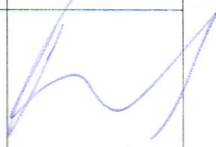
Minutes No. 3 dated "20" 12, 2024

Academic Council of KazNMU named after S.D. Asfendiyarov

Minutes No. 7 dated "17" 04, 2023

Developed by the Academic Committee of KazNRTU named after K.I. Satpayev for the program 6B071 "Engineering and Engineering Affairs" and the Educational Program Committee of the School of General Medicine of KazNMU named after S.D. Asfendiyarov for the program 6B101 "Healthcare"

Program Developers

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Alimbaev Chingiz Abdraimovich	Ph.D.	Associate professor of the department	Department of «Robotics and Engineering Tools of Automation», K.I.	

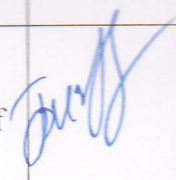
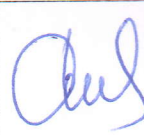
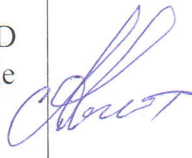
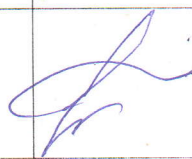
			Satbayev KazNRTU	
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Table of contents

1. Description of educational program
2. Purpose and objectives of educational program
3. Requirements for the evaluation of educational program learning outcomes
4. Passport of educational program
 - 4.1. General information
 - 4.2. Relationship between the achievability of the formed learning outcomes according to educational program and academic disciplines
5. Curriculum of educational program

1. Description of educational program

Biomedical engineering refers to the field of technology and scientific knowledge, which includes a set of means, methods and methods of human activity aimed at: participation in the organization and conduct of diagnostic studies and medical procedures using instrumental and hardware-software tools, in the conditions of medical organizations and institutions of various profiles; maintenance of standard medical equipment, devices, systems and complexes, as well as technical means of biological laboratories; processing of biomedical information, creation and operation of medical databases, use of modern software packages for information support of diagnostic and therapeutic processes.

The joint educational program "Biomedical Engineering" is based on the principles of an interdisciplinary approach, with the study of engineering and basic medical disciplines, including human biology, biophysics, the basics of human anatomy and physiology, the Basics of diagnostics of internal diseases, medical imaging.

The "Biomedical Engineering" educational program aims to train professional bachelors in the design and development of medical devices and biotechnical systems by deepening knowledge in engineering, as well as enabling them to apply innovative solutions in healthcare and implement sustainable development principles in biomedical engineering.

The objects of the bachelor's professional activity in the direction of "Biomedical Engineering" are devices, systems, complexes and basic medical technologies, as well as methods of research, therapeutic effects, information processing in practical healthcare and various fields of biomedical research.

Bachelor's degree in "Biomedical Engineering" in accordance with fundamental and special training can perform the following types of *professional activities*:

- *experimental research*;
- *repair and maintenance*;
- *organizational and managerial*;
- *production and technological*.

Bachelor's degree in "Biomedical Engineering" can adapt to the following types of professional activity:

- installation and commissioning works;
- operational and service maintenance.

Educational program "Biomedical Engineering" contains a complete list of academic disciplines, grouped in cycles: general education disciplines (GED), basic disciplines (BD) and profile disciplines (PD) as mandatory components, and components for selection, indicating the complexity of each subject in academic credits and hours established by the State obligatory standards of higher and postgraduate education, approved by order of MSHE RK №2 dated July 20, 2022.

The disciplines of the mandatory component of the GED cycle are aimed at forming the worldview, civic and moral positions of a future specialist who is competitive on the basis of knowledge of information and communication technologies, building communication programs in the state, Russian and foreign languages, focusing on a healthy lifestyle, self-improvement and professional success. The BD cycle includes studying academic subjects and passing professional practice. The PD cycle includes academic disciplines and types of professional practices. The programs of disciplines and modules of

the BD and PD cycles are interdisciplinary and multidisciplinary in nature, providing training at the junction of a number of areas of knowledge.

Final certification is carried out in the form of writing and defending a thesis (project) or preparing and passing a comprehensive exam.

The requirements for the level of training of students are determined based on the Dublin descriptors of the first level of higher education (bachelor's degree) and reflect the development of competence, expressed as outcomes of learning. Learning outcomes are formed both at the level of the entire educational program of higher education, and at the level of individual modules or academic disciplines.

Description compulsory standard requirements for graduation and assignment of the academic degree bachelor: on the volume of the educational program of bachelor degree is 240 credits, regardless of the form of education, applied educational technologies, the implementation of bachelor programs using a network form of realization of the program of bachelor in the individual curriculum, including accelerated learning.

Special requirements for University graduation in this program: Students who have passed the final certification, and who have confirmed the assimilation of the professional curriculum in the EP "Biomedical Engineering", the decision of the FC confers the academic degree "Bachelor of engineering and technology" in the educational program "Biomedical Engineering" and a diploma of its own sample with an Appendix is issued.

The issuance of diplomas of KazNRTU's own sample with an appendix and certificates with a transcript of KazNMU is issued on the basis of the order of the head of the university on the issue.

The diploma supplement is filled out on the basis of the student's individual curriculum in accordance with the grades he received in all disciplines to the extent provided for by the state mandatory standard of education and the working curriculum, submitted coursework (projects), types of practices and the results of the final certification.

In the appendix to the diploma, the latest grades for each academic discipline are recorded according to the point-rating letter system of knowledge assessments, indicating its volume in credits and in the ECTS scale.

2. Purpose and objectives of educational program

Purpose of EP:

Training of highly qualified specialists in biomedical engineering capable of ensuring the operation, maintenance, and modernization of biomedical equipment, considering aspects of bioethics and sustainable development, as well as ensuring the safety and efficiency of biomedical equipment.

Objectives of the EP:

- mastering fundamental knowledge in mathematics, physics, chemistry, biology, and engineering disciplines.
- developing competencies in sustainable development, digital biomedical technologies, and bioethics.
- forming skills in the operation, testing, and modernization of biomedical devices, considering principles of energy efficiency and waste minimization.
- mastering modern methods of analyzing and processing biomedical data using digital technologies.

Competencies at the end of studying

Generalcultural competences (GC)	
GC 1	The ability to communicate in oral and written forms in the state, Russian and foreign languages for solving problems of interpersonal and intercultural interaction
GC 2	Understanding and practical use of the norms of a healthy lifestyle, including issues of prevention, the ability to use physical culture to optimize performance
GC 3	The ability to analyze the main stages and patterns of the historical development of society for the formation of civic position
GC 4	Ability to use the foundations of philosophical knowledge to form a worldview
GC 5	The ability to critically use the methods of modern science in practice
GC 6	Awareness of the need and the acquisition of the ability to independently study and improve their qualifications throughout their working life
GC 7	Knowledge and understanding of professional ethical standards, mastery of professional communication techniques
GC 8	Ability to work in a team, tolerantly perceiving social, ethnic, confessional and cultural differences
GC 9	Ability to use the basics of economic knowledge in various fields of activity
General professional competencies (GPC)	
GPC 1	Knowledge of design methods for robotic and mechatronic systems, their individual subsystems and modules
GPC 2	Possession of modern software products for solving problems of system design, design of mechanical and mechatronic modules, control and information processing
GPC 3	Knowledge of mathematical models of robots, robotic and mechatronic systems, their individual subsystems and modules, carrying out their research using mathematical modeling, using both special and universal software tools, in order to substantiate the theoretical and design decisions
GPC 4	Understanding the physical processes and phenomena underlying the principles of operation of devices, equipment and systems

GPC 5	Knowledge of standards, methodological and regulatory materials accompanying the operation, installation and adjustment of modern mechatronic systems with digital control
Professional competence (PC)	
PC -1	Collection and analysis of scientific and technical information, taking into account current trends in the development and use of achievements of science, technology and technology in professional activities
PC -2	Evaluation of the economic efficiency of the implementation of the projected biomedical systems, their individual modules and subsystems
PC -3	Application of modern software products and the latest technologies for solving and managing interdisciplinary engineering problems in various fields of science and technology
PC -4	Assessment of the surrounding reality on the basis of worldview positions formed by knowledge of the fundamentals of philosophy, which provide scientific understanding and study of the natural and social world by methods of scientific and philosophical cognition
PC -5	Calculation and design of individual blocks and devices of biomedical systems, control, information-sensor and executive subsystems and mechatronic modules in accordance with the terms of reference
PC -6	Planning of tests of modules and subsystems of biomedical systems, participation in the organization and conduct of experiments at existing facilities and experimental models, processing of experimental research results using modern information technologies
PC -7	Monitoring compliance of technical documentation of the developed projects with standards and technological conditions
PC -8	Implementation of the results of theoretical developments in the production of biomedical systems, their subsystems and individual modules
PC -9	Organization of work on the operation, installation and commissioning of modern biomedical systems
PC -10	Organizing the activities of the production team, making organizational and managerial decisions in the context of different opinions and assessing the consequences of decisions taken

3. Requirements for evaluating the educational program learning outcomes

EO1 - Applies the laws of physics and radiation hygiene to control medical equipment in a clinical setting.

EO2 - He has the skills of planning tests of modules and subsystems of biomedical technology, organizing and conducting experimental research.

EO3 - Carries out repair, verification and maintenance of professional and household biomedical equipment.

EO4 - Ensures environmental and biological safety during the operation and maintenance of biomedical devices, acting within the regulatory and legal framework of the Republic of Kazakhstan.

EO5 - Possesses skills in organizing business processes and making organizational and managerial decisions.

EO6 - Applies the foundations of higher mathematics, physics, chemistry, biology, biophysics, anatomy, physiology to solve professional problems of biomedical engineering.

EO7 - Has the skills to study and analyze specialized literature and other scientific and technical information on the achievements of domestic and foreign science, technology and technology in the field of biomedical engineering.

EO8 - Has the skills of calculating and designing modern and reliable blocks and devices.

EO9 - Has the skills to use modern software packages for information support of diagnostic and therapeutic processes.

EO10 - Possesses research skills in the field of developing new samples and improving existing biomedical devices and devices.

4. Passport of educational program

4.1. General information

No.	Field name	Comments
1	Code and classification of the field of education	6B07 «Engineering, Manufacturing and Civil engineering»
2	Code and classification of training directions	6B071 «Engineering and engineering trades»
3	Educational program group	B063 «Electrical engineering and automation»
4	Educational program name	6B07114 «Biomedical Engineering»
5	Short description of educational program	Training of highly qualified specialists in the field of medical and environmental engineering and technology, creation and maintenance of tools for diagnosis, treatment, rehabilitation and prevention of human diseases and elaboration of software to solve practical and theoretical problems of biomedical practice.
6	Purpose of EP	The purpose of the educational program is training of highly qualified specialists in biomedical engineering capable of ensuring the operation, maintenance, and modernization of biomedical equipment, considering aspects of bioethics and sustainable development, as well as ensuring the safety and efficiency of biomedical equipment.
7	Type of EP	Innovative
8	The level based on NQF	6
9	The level based on SQF	6
10	EP distinctive features	Joint EP with KazNMU named after S.D. Asfendiyarov
11	List of competencies of the educational program:	Providing a wide range of theoretical and practical knowledge in the professional field; the ability to develop methodological and regulatory documents, technical documentation, as well as the implementation of measures for the implementation of developed projects and programs; the ability to make decisions based on the results of calculations on projects and the results of technical, economic and functional cost analysis of the effectiveness of projected biomedical systems; evaluating the economic effectiveness of the implementation of projected biomedical systems, their individual modules and subsystems (PC1-PC10).
12	Learning outcomes of the educational program:	EO1 - Applies the laws of physics and radiation hygiene to control medical equipment in a clinical setting. EO2 - He has the skills of planning tests of modules and subsystems of biomedical technology, organizing and conducting experimental research. EO3 - Carries out repair, verification and maintenance of professional and household biomedical equipment. EO4 - Ensures environmental and biological safety during the operation and maintenance of biomedical devices, acting within the regulatory and legal framework of the Republic of Kazakhstan.

		EO5 - Possesses skills in organizing business processes and making organizational and managerial decisions. EO6 - Applies the foundations of higher mathematics, physics, chemistry, biology, biophysics, anatomy, physiology to solve professional problems of biomedical engineering. EO7 - Has the skills to study and analyze specialized literature and other scientific and technical information on the achievements of domestic and foreign science, technology and technology in the field of biomedical engineering. EO8 - Has the skills of calculating and designing modern and reliable blocks and devices. EO9 - Has the skills to use modern software packages for information support of diagnostic and therapeutic processes. EO10 - Possesses research skills in the field of developing new samples and improving existing biomedical devices and devices.
13	Form of training	full-time
14	Period of study	4 year
15	Volume of the credits	240
16	Language of education	russian, kazakh, english
17	The awarded academic degree	Bachelor of Engineering and Technology
18	Develop and author	Ozhikenov K.A.

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

No.	Discipline name	Short description of discipline	Amount of credits	Generated learning outcomes (codes)									
				EO1	EO2	EO3	EO4	EO5	EO6	EO7	EO8	EO9	EO10
Cycle of general education disciplines													
Main choice													
1.	English language	English is a compulsory subject. According to the results of placement test or IELTS score, students are placed into groups and disciplines. The name of the discipline corresponds to the level of English. When passing from level to level, prerequisites and postrequisites are respected.	5										
2.	Kazakh (Russian) language	Kazakh (Russian) language In this course author considers socio-political, socio-cultural spheres of communication and functional styles of the modern kazakh (russian) language. The course covers the specifics of the scientific style to develop and activate professional communication skills and abilities of students. Also it allows students to leavn the basics of scientific style practically and develop the ability of production structural and semantic text analysis	5										
3.	Physical Culture	The purpose of the discipline is to master the forms and methods of forming a healthy lifestyle within the framework of the professional education system. Familiarization with the natural-scientific basics of physical education, knowledge of modern health-improving technologies, basic methods of independent physical education and sports. As part of the course, the student will master the rules of judging in all sports.	8										
4.	Information and communication technologies (in English)	The aim of the course is to gain theoretical knowledge in information processing, the latest information technologies, local and global networks, the methods of information protection; Getting the right use of text editor editors and tabulators; creation of base and different categories of applications.	5										
5.	History of Kazakhstan	The purpose of the discipline is to provide objective historical knowledge about the main stages of the history of Kazakhstan from ancient times to the present day; introduce students to the problems of the formation and development of statehood and historical and cultural processes; contribute to the formation of humanistic values and patriotic feelings in the student; teach the student to use the acquired historical knowledge in educational, professional and everyday life; evaluate the role of Kazakhstan in world history.	5										
6.	Philosophy	The purpose of the discipline is to teach students the theoretical foundations of philosophy as a way of knowing and spiritually mastering the world; developing their interest in fundamental knowledge, stimulating the need for philosophical assessments of historical events and facts of reality, assimilating the idea of the unity of the world historical and cultural process while recognizing the diversity of their skills in applying philosophical and general scientific methods in professional activities.	5										
7.	Socio-political knowledge	The objectives of the disciplines are to provide students with explanations on the	3										

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	module (sociology, politology)	sociological analysis of society, about social communities and personality, factors and patterns of social development, forms of interaction, types and directions of social processes, forms of regulation of social behavior, as well as primary political knowledge that will serve as a theoretical basis for understanding social -political processes, for the formation of political culture, development of a personal position and a clearer understanding of the extent of one's responsibility; help to master the political, legal, moral, ethical and socio-cultural norms necessary to act in the interests of society, form personal responsibility and achieve personal success.											
8.	Socio-political knowledge module (culturology, psychology)	The purpose of the disciplines is to study the real processes of cultural creative activity of people who create material and spiritual values, identify the main trends and patterns of cultural development, changes in cultural eras, methods and styles, their role in the formation of man and the development of society, as well as master psychological knowledge for the effective organization of interpersonal interaction, social adaptation in the field of their professional activities.	5										
Cycle of general education disciplines Component of choice													
9.	Fundamentals of anti-corruption culture and law	Purpose: to increase the public and individual legal awareness and legal culture of students, as well as the formation of a knowledge system and a civic position on combating corruption as an antisocial phenomenon. Contents: improvement of socio-economic relations of the Kazakh society, psychological features of corrupt behavior, formation of an anti-corruption culture, legal responsibility for acts of corruption in various fields.	5					v					
10.	Fundamentals of scientific research methods	Purpose: to form knowledge about scientific research, methods and methodology of scientific research, methods of collecting and processing scientific data in modern science. Contents: fundamentals of the theory of solving inventive problems, with algorithmic methods of searching for technical solutions and their optimization, basic mathematical optimization methods, the use of artificial intelligence capabilities to solve optimization problems, issues of search, accumulation and processing of scientific information.	5							v			
11.	Fundamentals of economics and entrepreneurship	Purpose: To develop basic knowledge of economic processes and skills in entrepreneurial activities. Content: The course aims to develop skills in analyzing economic concepts such as supply and demand, and market equilibrium. It includes the basics of creating and managing a business, developing business plans, risk assessment, and strategic decision-making.	5					v					
12.	Ecology and life safety	Purpose: formation of ecological knowledge and consciousness, obtaining theoretical and practical knowledge on modern methods of rational use of natural resources and environmental protection. Contents: the study of the tasks of ecology as a science, the laws of the functioning of natural systems and aspects of environmental safety in working conditions, environmental monitoring and management in the field of its safety, ways to solve environmental problems; life safety in the technosphere, emergencies of a natural and man-made nature.	5					v					
13.	Basics of Financial Literacy	Purpose: formation of financial literacy of students on the basis of building a direct link between the acquired knowledge and their practical application. Contents:	5					v			v		

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		using in practice all kinds of tools in the field of financial management, saving and increasing savings, competent budget planning, obtaining practical skills in calculating, paying taxes and correctly filling out tax reports, analyzing financial information, orienting in financial products to choose adequate investment strategies.												
Cycle of basic disciplines University component														
14.	The theory of automatic control	Purpose: disciplines mastering the principles of object management, methods of building models of automatic control systems and research of processes in these systems. Content: the course "Theory of automatic control" examines the processes of automatic control of objects and the use of software tools for the analysis of automatic control systems. At the same time, using mathematical tools, the properties of automatic control systems are identified and recommendations for their design are developed.	5	v						v				
15.	Biomedical engineering	Introduction to the main directions and problems of fundamental and applied research in biomedical engineering. Analysis of the main trends in the development of biomedical engineering, identification of its promising areas and opportunities for practical application. Formation of future specialists' knowledge on modern problems of biomedical nanoengineering, as well as practical skills of predictive assessments of innovative directions of its development	5									v		v
16.	Biomedical electronics	The discipline is aimed at studying the sections of electronics, the features of the use of electronic systems for solving biomedical problems; familiarization with devices for receiving, transmitting and registering biomedical information; studying the effects of electric current on the body or organs of a biological object, the resistance of internal tissues and organs and skin; formation of the ability to safely use electronic medical equipment	5	v				v						
17.	Biophysics	The discipline will provide in-depth knowledge of the features of the manifestation of physical laws in biological systems, understanding of the device and operation of medical equipment. The study of the primary effects of physical factors on the human body; the application of physical laws to explain the processes occurring in the body.	5	v						v				
18.	Engineering and computer graphics	Purpose: To develop students' knowledge of drawing construction and skills in developing graphical and textual design documentation in accordance with standards. Content: Students will study ESKD standards, graphic primitives, geometric constructions, methods and properties of orthogonal projection, Monge's projection, axonometric projections, metric tasks, types and features of connections, creating part sketches and assembly drawings, detailing, and creating complex 3D solid objects in AutoCAD.	5									v		
19.	Integral microprocessor and circuit design	The discipline is aimed at familiarizing students with the basics of digital integrated circuitry and their practical application in robotics, getting an idea of the development of integrated digital circuitry, architecture and programming of typical microprocessor systems, methods of automated modeling and design of electronic circuits	5							v				

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20.	Mathematics I	Purpose: to introduce students to the fundamental concepts of linear algebra, analytical geometry and mathematical analysis. To form the ability to solve typical and applied problems of the discipline. Contents_ Elements of linear algebra, vector algebra and analytical geometry. Introduction to the analysis. Differential calculus of a function of one variable. The study of functions using derivatives. Functions of several variables. Partial derivatives. The extremum of a function of two variables.	5						v				
21.	Mathematics II	Purpose: To teach students integration methods. To teach you how to choose the right method for finding the primitive. To teach how to apply a certain integral to solve practical problems. Contents_ integral calculus of the function of one and two variables, series theory. Indefinite integrals, methods of their calculation. Certain integrals and applications of certain integrals. Improper integrals. Theory of numerical and functional series, Taylor and Maclaurin series, application of series to approximate calculations	5						v				
22.	Mathematics III	Purpose: To teach students integration methods. To teach you how to choose the right method for finding the primitive. The discipline is a continuation of Mathematics II. The course includes sections: ordinary differential equations and elements of probability theory and mathematical statistics. Differential equations with separable variables, homogeneous, in full differentials, linear inhomogeneous differential equations with constant coefficients, systems of linear differential equations with constant coefficients, finding the probability of events, calculating the numerical characteristics of random variables, using statistical methods for processing experimental data are studied.	5						v				
23.	Medical imaging	The discipline forms knowledge and skills of the regulatory framework and physical and technical foundations of medical radiology, determination of indications and contraindications, skills of conducting radiological research with an assessment of its risks in achieving the best results for the patient within the framework of technical professional activity	5	v			v						
24.	Mechanics of controlled machines	The course is aimed at studying methods for controlling dynamic systems and estimating their state; mastering the methods of designing optimal control systems; application of the studied methods and algorithms for solving problems related to the control of mechatronic machines; study of various drive elements and structures in the overall system for constructing controlled mechatronic machines.	5								v		
25.	General Chemistry	The purpose of the discipline is to study the basic concepts and laws of chemistry; fundamental laws of chemical thermodynamics and kinetics; quantum mechanical theory of atomic structure and chemical bonding. Solutions and their types, redox processes, coordination compounds: formation, stability and properties. The structure of matter and the chemistry of elements.	4						v				
26.	Fundamentals of human anatomy	The discipline of studying human anatomy is the form and structure, origin and development of the human body. Human anatomy is one of the fundamental disciplines in the system of medical and biological education, closely related to such disciplines as anthropology and human physiology, as well as comparative anatomy, evolutionary theory and genetics.	5						v				
27.	Fundamentals of Human	The discipline is aimed at studying the nature of man as a biological being, the	5						v				

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	Biology	processes of human life, his organs and tissues. The study of the discipline "Fundamentals of Human Biology" will allow students to understand the processes occurring in the human body at the cellular and molecular level when using modern molecular genetic, cytogenetic and molecular cytogenetic methods of studying genetic material.											
28.	Fundamentals of diagnostics of internal diseases	The discipline is aimed at using the basics of engineering in medicine and methods of using medical equipment in clinical practice; studying methods of application and implementation of medical technologies to optimize the provision of medical services.	5	v								v	
29.	Basics of information-measuring technology	The purpose of the discipline is to study general information about the measurement of physical quantities, methods and means of measurement, measurement and information systems. The study of the main methods and means of measuring electrical, magnetic and non-electrical quantities, methods for evaluating the accuracy of measurement results, familiarization of students with modern measuring technologies and their application.	5						v				
30.	Fundamentals of human physiology	The discipline is aimed at studying the vital activity of a living organism as a whole and its individual parts - cells, tissues, organs, systems. The subject of the study of physiology is the functions of the body, their relationship to each other, the mechanisms of regulation and interaction with the environment.	5						v				
31.	Fundamentals of electromechanics and electronics	The discipline is aimed at studying a variety of electromechanical and electronic devices existing on the market, and related phenomena; the study of a single-phase transformer, a DC motor and generator, synchronous and asynchronous motors, semiconductor devices, analog electronic devices, the basics of digital technology	6						v				
32.	Programming in a high level language	Purpose: The aim of the discipline is to develop a free and creative approach to programming in modern high-level languages, and an interest in observing trends and news in the field of software development tools. Contents: the basic principles of programming in high-level languages and their application in solving applied problems. The study of the discipline should contribute to the formation of the foundations of scientific thinking among students.	5									v	
33.	Physics I	Purpose: to study the basic physical phenomena and laws of classical and modern physics; methods of physical research; the influence of physics on the development of technology; the relationship of physics with other sciences and its role in solving scientific and technical problems of the specialty. Contents: mechanics, dynamics of rotational motion of a solid body, mechanical harmonic waves, fundamentals of molecular-kinetic theory and thermodynamics, transfer phenomena, continuum mechanics, electrostatics, direct current, magnetic field, Maxwell's equations.	5						v				
34.	Physics II	Purpose: to form students' knowledge and skills in using fundamental laws, theories of classical and modern physics, as well as methods of physical research as the basis of a system of professional activity. Contents: harmonic oscillations, damped oscillations, alternating current, wave motion, laws of refraction and reflection of light, quantum optics, laws of thermal radiation, photons, their characteristics, wave function, electrical conductivity of metals, atomic nucleus, its structure and properties, binding energy, radioactivity.	5						v				

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named after K.I.SATBAYEV»

35.	Metrological support of measuring sensory information	Purpose: the purpose of this course is to study the basics of metrological support for information and measurement systems. Content: the course includes preparation for solving general scientific and technical problems in the field of metrological support of information and measurement systems; familiarization with the basics of building information and measurement systems and the structure of their channels; study of basic metrological characteristics, basic methods and means of verification and calibration of measuring channels of information and measurement systems.	4			v								
36.	Educational practice	Formation of students' basic professional skills in the field of robotics and mechatronics, mastering the basics of designing, assembling and programming simple robotic systems.	2	v										
Cycle of basic disciplines Component of choice														
37.	Legal regulation of intellectual property	Purpose: the goal is to form a holistic understanding of the system of legal regulation of intellectual property, including basic principles, mechanisms for protecting intellectual property rights and features of their implementation. Content: The discipline covers the basics of IP law, including copyright, patents, trademarks, and industrial designs. Students learn how to protect and manage intellectual property rights, and consider legal disputes and methods for resolving them.	5				v							
38.	Fundamentals of sustainable development and ESG projects in Kazakhstan	Purpose: the goal is for students to master the theoretical foundations and practical skills in the field of sustainable development and ESG, as well as to develop an understanding of the role of these aspects in the modern economic and social development of Kazakhstan. Contents: introduces the principles of sustainable development and the implementation of ESG practices in Kazakhstan, includes the study of national and international standards, analysis of successful ESG projects and strategies for their implementation in enterprises and organizations.	5				v							
39.	ESG principles in inclusive culture	Purpose of the course: It focuses on studying ESG (Environmental, Social, Governance) principles and their interaction with the creation of an inclusive culture within an organization. Content: Students will gain knowledge on how implementing ESG principles contributes to corporate social responsibility, sustainable development, and equal opportunities for all employees, including those who may face various forms of discrimination. The course will help students understand the importance of an inclusive culture in achieving long-term business goals and ensuring sustainable organizational development.	5				v							
40.	Programming for microcontrollers	Purpose: train students in programming microcontrollers, connecting sensors and devices, as well as developing robot control algorithms for students in mechatronics and robotics. Content: The discipline "Programming for microcontrollers" is a fundamental discipline for the study of microcontroller control of robots. The course is intended for students of the field of mechatronics and robotics.	5										v	
41.	Fundamentals of Artificial Intelligence	Purpose: to familiarize students with the basic concepts, methods and technologies in the field of artificial intelligence: machine learning, computer vision, natural language processing, etc. Contents: general definition of artificial intelligence, intelligent agents, information retrieval and state space exploration, logical agents, architecture of artificial intelligence systems, expert systems, observational	5									v		v

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		learning, statistical learning methods, probabilistic processing of linguistic information, semantic models, natural language processing systems.												
42.	Management in biotechnical systems	The discipline is aimed at the formation of knowledge on the theory of automatic control and various methods of optimizing management decisions used in the creation of biotechnical systems for various purposes; the study of dynamic characteristics of electric drives of biotechnical systems; the study of methods for assessing the stability and quality of automatic systems.	4											v
43.	Machine learning for biomedical applications	Purpose: to study the basic principles of the application of machine learning and to gain skills in applying machine learning algorithms to solve practical problems in the field of medicine. Content: machine learning algorithms in applied problems of classification of medical images. Neural networks as self-learning structures. The basic principles of building neural networks. The neuron and its mathematical description. Activation functions, their role and main types. Criteria for training neural networks, loss function.	4										v	
Cycle of profile disciplines University component														
44.	Programming for engineers with MATLAB	The discipline is aimed at studying typical mathematical schemes for modeling systems, familiarizing with the main approaches to simulating systems, studying modern methods of simulating physical control processes in devices, in technical means of automation and technological processes in the MATLAB environment.	5										v	
45.	Thermodynamics of biological systems	The discipline is aimed at mastering the basic methods of mathematical modeling in the thermodynamics of biological systems and methods for solving problems arising in this case; studying the theoretical foundations of thermodynamics; studying the features of applying thermodynamic methods for biological systems; forming the ability to apply theoretical knowledge to solve practical problems of analyzing models of biotechnical systems; forming skills of thermodynamic research of biotechnical models of living structures	4							v				
46.	Production practice I	Consolidation of theoretical knowledge and obtaining primary production experience in a real or educational laboratory enterprise, familiarization with the operation of equipment, automation systems and basic maintenance processes.	2					v						
47.	Production practice II	Acquisition of practical skills in independent engineering, work on an applied project in an enterprise or laboratory, preparation for final qualifying work.	3										v	
Cycle of profile disciplines Component of choice														
48.	Artificial life support equipment	Purpose and classification of artificial life support equipment: by the method of reproducing the function of an organ or system; by the method of use; by the type of substitution of the function of an organ or system. The objectives of the course are to study the devices and general principles of artificial life support equipment, engineering research methods to solve various problems of medicine.	6		v						v			
49.	Biotechnical and medical diagnostic equipment	The discipline "Biotechnical and medical diagnostic equipment" is aimed at studying the formation of professional competencies in the use of modern information and computer technologies for diagnosis, treatment, control and monitoring of health, optimization of the treatment process in medical institutions	6								v			v

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named after K.I.SATBAYEV»

50.	Bio - liquids	Purpose: The purpose of mastering the discipline "Bio-fluids" is to study the rheological properties of blood and the issues of its modeling in biomechanics. Contents: human biological fluids — liquids produced by the human body (pus, blood, lymph, sputum, bile, colostrum, urine, prostate secretion, mucus of mucous membranes, synovial fluid, semen, cerebrospinal fluid, tissue fluid, pleural fluid, nasal mucus, sweat, transudate, earwax and exudate).	5						v				
51.	Biomaterials	Purpose: to form an integrated system of knowledge among students about the diversity of biomaterials, the methodology of their synthesis and analysis of inorganic biomaterials used in medicine. Content: the concept of "biomaterials". Relevance and needs for new biomaterials. Diversity and methods of classification of biomaterials. Characteristics of the main groups of biomaterials. Trends in the development of modern materials science. The most important problems of materials science for the near and more distant future. Typ Classification biomaterials according to the degree of porosity. Features of biomaterial technology. Biomaterial production: problems and prospects.	5						v				
52.	Inspection and testing of medical equipment	The discipline is aimed at developing students' knowledge of the principles of operation, maintenance, and quality control of biomedical devices, biotechnical systems, and apparatuses. It includes studying methods for assessing energy efficiency, analyzing the life cycle of biomedical equipment, and minimizing waste. Modern regulatory requirements in the field of sustainable development, regulatory procedures for the verification and certification of biomedical equipment, as well as methods for ensuring safety during its development, production, and operation are considered.	5			v	v						
53.	Cardiotechnics	The discipline "Cardiotechnics" is aimed at teaching the recognition of electrocardiographic criteria for cardiac conduction disorders: atrioventricular blockade of various degrees, sino-atrial blockade of various degrees, asystole. To teach recognition of electrocardiographic criteria of paroxysmal tachycardia: supraventricular, ventricular, ventricular fibrillation, as well as diagnostic criteria for life-threatening rhythm and conduction disorders.	5						v				
54.	Modeling in biomechanics	Purpose: Objective: to involve students in research in the interdisciplinary field of mathematical modeling in biomechanics and medicine. Content: it is aimed at forming a complex of systematic knowledge about modern approaches and methods of mathematical modeling in solving problems of biomechanics and medicine (immunology).	5										v
55.	Statistical modeling of systems	Purpose: to familiarize students with the methods of statistical modeling used in solving complex problems of process control, analysis, optimization, and design. Content: relevance and significance of the problems of simulation and statistical modeling. Some concepts and theorems of probability theory. The method of statistical tests. The Monte Carlo method. The Monte Carlo method significantly influences the development of computational mathematics methods (for example, the development of numerical integration methods).	5								v		
56.	Engineering biomechanics	Purpose: to familiarize students with the general basics of biomechanics as a science of human movements. Contents: the discipline is aimed at training a specialist with	5	v					v				

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named after K.I.SATBAYEV»

		deep knowledge and skills in the development and construction of medical robots and manipulators, bioprotheses and exoskeletons; studying the movements of biological objects; mechanical phenomena in tissues, organs and systems; studying the methods of application of technical devices in biological and medical practice.											
57.	Orthopedic Biomechanics	Purpose: Formation of professional knowledge in the field of Traumatology, study of the theoretical and methodological foundations of the specialty Contents: the discipline "Orthopedic biomechanics" is aimed at training a specialist with in-depth knowledge and skills in the field of prevention, diagnosis and orthopedic methods of treatment of anomalies, defects and deformations of the orthopedic system. Formation of professional knowledge in the field of traumatology, study of the theoretical and methodological foundations of the specialty, treatment and prevention of injuries of the musculoskeletal system, orthopedic diseases.	5	v								v	
58.	Fundamentals of medical optics	The discipline studies methods of information transformation and processing in optical devices, systems and complexes used in medicine. They study the physical foundations of phenomena related to the interaction of light with matter; the main classical and modern experimental results in the field of optical phenomena; the basic laws of geometric and wave optics, the main methods for solving optical problems.	4						v				
59.	Sensors in medicine	The purpose of this course is to familiarize students with modern biomedical devices, the principles of their design and functioning. The course introduces students to modern devices for the diagnosis, monitoring and therapy of various diseases. The basic principles of their design and functioning are considered. Special attention is paid to the materials used to create biomedical devices.	4	v									
60.	Machine learning theory and neural networks.	The discipline studies methods of constructing algorithms capable of learning, namely deductive learning, which involves the formalization of expert knowledge and their transfer to a computer in the form of a knowledge base. A characteristic feature of machine learning is not a direct solution, but learning in the process of applying solutions to many similar problems.	6									v	
61.	Microcontroller control systems	The discipline is aimed at studying the basic principles of building microprocessor systems and modern architectures of microcontrollers; mastering methods and tools for the development of microcontroller systems for collecting and processing information; acquisition of skills in managing various sensors and solving the problem of microprocessor control.	6								v		
62.	Processing and analysis of biomedical signals and data	Purpose: formation of competencies in the field of methods and algorithms for processing biomedical signals and data used in the creation of biotechnical and medical systems. Content: a brief summary of the development of biomedical signal and data processing methods. The importance of the development of this field for medical instrumentation and biotechnical systems. The role of automation of processing and analysis of biomedical signals in improving medical diagnostics.	6	v								v	
63.	Processing of biomedical images	Purpose: The discipline is the study of principles, methods of processing and analyzing medical images and the formation of skills and abilities to solve problems of video analytics in the field of medical video systems. Content: fundamentals of digital processing of medical video data in order to improve their visual quality and	6									v	

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named after K.I.SATBAYEV»

		ergonomics; fundamentals of data mining for the purpose of segmentation and classification of objects of interest in medical images; capabilities of modern tools and programming systems for solving machine learning problems; knowledge of the basics of smart visualization methods.											
64.	Design in cardiology	Purpose: to form a technological base for innovative fundamental, exploratory and applied scientific research on the development and implementation of new medical technologies for the diagnosis and treatment of cardiovascular diseases; Content: Conducting a full innovative cycle of research and development work, including the creation of industrial designs, in priority areas of development of medical science, technology and cardiac engineering	5		v						v		
65.	Designing in orthopedics	Purpose: the purpose of studying the discipline is to acquire the knowledge necessary for conducting scientific research in the field of traumatology and orthopedics. Contents: Types of diagnosis of injuries and diseases of the musculoskeletal system. The role of radiological methods in the diagnosis of diseases and injuries of the musculoskeletal system. Tomographic methods for the diagnosis of bone and soft tissue injuries in trauma and orthopedic pathology	5		v						v		

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		3 course		4 course			
									1 sem	2 sem	3 sem	4 sem	5 sem	6 sem	7 sem	8 sem		
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)																		
M-1. Module of language training																		
LNG108	Foreign language		GED, RC	5	150	0/0/45	105	E	5									
LNG104	Kazakh (russian) language		GED, RC	5	150	0/0/45	105	E	5									
LNG108	Foreign language		GED, RC	5	150	0/0/45	105	E		5								
LNG104	Kazakh (russian) language		GED, RC	5	150	0/0/45	105	E		5								
M-2. Module of physical training																		
KFK101	Physical culture I		GED, RC	2	60	0/0/30	30	E	2									
KFK102	Physical culture II		GED, RC	2	60	0/0/30	30	E		2								
KFK103	Physical culture III		GED, RC	2	60	0/0/30	30	E			2							
KFK104	Physical culture IV		GED, RC	2	60	0/0/30	30	E				2						
M-3. Module of information technology																		
CSE677	Information and communication technology		GED, RC	5	150	30/15/0	105	E			5							
M-4. Module of socio-cultural development																		
HUM137	History of Kazakhstan		GED, RC	5	150	15/0/30	105	GE	5									
HUM120	Module of socio-political knowledge (sociology, political science)		GED, RC	3	90	15/0/15	60	E			3							
HUM134	Module of socio-political knowledge (cultural studies, psychology)		GED, RC	5	150	30/0/15	105	E				5						
HUM132	Philosophy		GED, RC	5	150	15/0/30	105	E						5				
M-5. Module of anti-corruption culture, ecology and life safety base																		
HUM136	Fundamentals of anti-corruption culture and law	1	GED, CCH	5	150	30/0/15	105	E					5					
MNG489	Fundamentals of economics and entrepreneurship	1	GED, CCH	5	150	30/0/15	105	E					5					
ELC577	Fundamentals of scientific research methods	1	GED, CCH	5	150	30/0/15	105	E					5					
CHE656	Ecology and life safety	1	GED, CCH	5	150	30/0/15	105	E					5					
MNG564	Basics of Financial Literacy	1	GED, CCH	5	150	30/0/15	105	E					5					
CYCLE OF BASIC DISCIPLINES (BD)																		
M-3. Module of information technology																		
GEN429	Engineering and computer graphics		BD, UC	5	150	15/0/30	105	E		5								
M-6. Mathematical training module																		

MAT101	Mathematics I		BD, UC	5	150	15/0/30	105	E	5								
MAT102	Mathematics II		BD, UC	5	150	15/0/30	105	E		5							MAT101
MAT103	Mathematics III		BD, UC	5	150	15/0/30	105	E			5						MAT102
M-7. Module of basic training																	
PHY111	Physics I		BD, UC	5	150	15/15/15	105	E	5								
CHE846	General Chemistry		BD, UC	4	120	15/15/15	75	E	4								
PHY112	Physics II		BD, UC	5	150	15/15/15	105	E		5							PHY111
M-8. Human Biology Module																	
ROB600	Fundamentals of Human Biology		BD, UC	5	150	15/0/30	105	E			5						
ROB601	Biophysics		BD, UC	5	150	15/0/30	105	E			5						
ROB602	Fundamentals of human anatomy		BD, UC	5	150	15/0/30	105	E				5					
ROB603	Fundamentals of human physiology		BD, UC	5	150	15/0/30	105	E				5					
M-9. Electronics and Circuit Engineering module																	
ROB538	Fundamentals of electromechanics and electronics		BD, UC	6	180	30/15/15	120	E			6						
ROB572	Biomedical electronics		BD, UC	5	150	15/15/15	105	E				5					
ROB573	Integral and microprocessor circuit design	1	BD, CCH	5	150	30/15/0	105	E					5				
MNG562	Legal regulation of intellectual property	1	BD, CCH	5	150	30/0/15	105	E					5				
MNG563	Fundamentals of sustainable development and ESG projects in Kazakhstan	1	BD, CCH	5	150	30/0/15	105	E					5				
CHE950	ESG principles in inclusive culture	1	BD, CCH	5	150	30/0/15	105	E					5				
M-11. Programming module																	
ROB650	Programming for microcontrollers	1	BD, CCH	5	150	15/15/15	105	E					5				
ROB615	Programming in a high level language	1	BD, CCH	5	150	15/15/15	105	E					5				
CSE831	Fundamentals of Artificial Intelligence	1	BD, CCH	5	150	15/0/30	105	E					5				
M-12. Measurement and processing module																	
ROB187	Basics of information-measuring technology		BD, UC	5	150	30/15/0	105	E					5				
ROB619	Metrological support of measuring sensory information		BD, UC	4	120	15/0/30	75	E						4			
M-13. Control module																	
ROB622	The theory of automatic control		BD, UC	5	150	15/15/15	105	E						5			
ROB534	Mechanics of controlled machines		BD, UC	5	150	30/0/15	105	E							5		
M-14. Biomedical Engineering Module																	
ROB412	Biomedical engineering		BD, UC	5	150	30/0/15	105	E				5					
M-15. Clinical Engineering Module																	
ROB599	Fundamentals of diagnostics of internal diseases		BD, UC	5	150	0/0/45	105	E					5				
ROB604	Medical imaging		BD, UC	5	150	0/0/45	105	E						5			
ROB545	Microcontroller control systems	1	BD, CCH	4	120	15/15/15	75	E						4			
ROB617	Machine learning for biomedical applications	1	BD, CCH	4	120	15/0/30	75	E						4			
M-17. Practice-oriented module																	
AAP173	Practical training		BD, UC	2				R		2							
CYCLE OF PROFILE DISCIPLINES (PD)																	
M-10. Biomechanics Module																	
ROB611	Engineering biomechanics	1	PD, CCH	5	150	15/0/30	105	E					5				
ROB612	Orthopedic biomechanics	1	PD, CCH	5	150	15/0/30	105	E					5				
ROB569	Thermodynamics of biological systems		PD, UC	4	120	15/15/15	75	E						4			
ROB613	Bio - liquids	1	PD, CCH	5	150	15/0/30	105	E							5		
ROB614	Biomaterials	1	PD, CCH	5	150	15/0/30	105	E							5		
M-11. Programming module																	
ROB528	ICT - Programming for engineers with MATLAB		PD, UC	5	150	15/0/30	105	E							5		
M-12. Measurement and processing module																	
ROB620	Processing and analysis of biomedical signals and data	1	PD, CCH	6	180	15/15/30	120	E							6		

ROB621	Processing of biomedical images	1	PD, CCH	6	180	15/15/30	120	E								6		
M-13. Control module																		
ROB609	Management in biotechnical systems	1	PD, CCH	6	180	30/15/15	120	E								6		
ROB610	Machine learning theory and neural networks.	1	PD, CCH	6	180	15/15/30	120	E								6		
M-14. Biomedical Engineering Module																		
ROB565	Artificial life support equipment	1	PD, CCH	6	180	15/15/30	120	E								6		
ROB566	Biotechnical and medical diagnostic equipment	1	PD, CCH	6	180	15/15/30	120	E								6		
ROB605	Fundamentals of medical optics	1	PD, CCH	4	120	15/15/15	75	E									4	
ROB606	Sensors in medicine	1	PD, CCH	4	120	30/15/0	75	E									4	
ROB417	Inspection and testing of medical equipment	2	PD, CCH	5	150	30/0/15	105	E									5	
ROB567	Cardiotechnics	2	PD, CCH	5	150	15/15/15	105	E									5	
M-16. R&D Module																		
ROB634	Design in cardiology	1	PD, CCH	5	150	0/0/45	105	C									5	
ROB635	Designing in orthopedics	1	PD, CCH	5	150	0/0/45	105	C									5	
ROB636	Modeling in biomechanics	2	PD, CCH	5	150	15/15/15	105	C									5	
ROB637	Statistical modeling of systems	2	PD, CCH	5	150	15/15/15	105	C									5	
M-17. Practice-oriented module																		
AAP102	Production practice I		PD, UC	2				R					2					
AAP183	Production practice II		PD, UC	3				R							3			
M-18. Module of final attestation																		
ECA103	Final examination		FA	8													8	
Additional type of training (ATT)																		
AAP500	Military training																	
Total based on UNIVERSITY:										31	29	31	29	30	30	33	27	
										60		60		60		60		

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	51	0	5	56
BD	Cycle of basic disciplines	0	101	14	115
PD	Cycle of profile disciplines	0	14	47	61
Total for theoretical training:		51	115	66	232
FA	Final attestation				8
TOTAL::					240

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 № 4 dated 22.11.2024

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.

acting Director of Institute - Institute of Automation and
Information Technologies

Chinibayev Y. T.

Department Chair - Robotics and automation equipment

Ozhikenov K. .

Representative of the Academic Committee from Employers
____Acknowledged____

Dzhumagulov A.

