

**NCJS «KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY
named after K.I.SATBAYEV»
KAZAKH NATIONAL MEDICAL UNIVERSITY named after S.D.
ASFENDIYAROV**

APPROVED

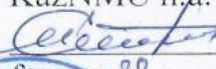
Chairman of the Board – Rector
KazNRTU n.a. K.I.Satbayev


M.M. Begentayev
from «04» 05 2023y.



APPROVED

Chairman of the Board – Rector
KazNMU n.a. S.D. Asfendiyarov


M.E. Shoranov
from «28» 04 2023y



**JOINT EDUCATIONAL PROGRAM
6B07114 - Biomedical Engineering**

**Code and classification of
the field of education:**

6B07 Manufacturing and processing industries

**Code and classification of
training directions:**

6B071 Engineering and engineering trades

**Group of educational
programs:**

B063 Electrical engineering and automation

Level on NQF:

6

Level on SQF:

Period of study:

4 year

Volume of the credits:

240 ECTS

Almaty 2023

Joint educational program 6B07114 - Biomedical engineering approved at the meeting of the Academic Council

KazNRTU n.a. K.I.Satbayev Minutes No. 5 from «24» 11 2022y.

KazNMU n.a. S.D. Asfendiyarov Minutes No. 10 from «26» 04 2023y.

Reviewed and recommended for approval at the meeting

Educational and Methodological Council of KazNRTU n.a. K.I.Satbayev

Minutes No. 3 from «17» 11 2022y.

Academic Council of KazNMU n.a. S.D. Asfendiyarov

Minutes No. 7 from «17» 04 2023y.

Developed by the academic committee of KazNRTU n.a. K.I.Satbayev in the direction 6B071 «Engineering and engineering trades» and the committee of educational programs of the School of General Medicine KazNMU n.a. S.D. Asfendiyarov in the direction 6B101 «Healthcare»

JEP Developers





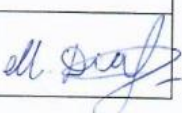
Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairman of the Academic Committee of KazNRTU n.a. K.I.Satbayev:				
Baktybaev M.K.	Candidate of Physical and Mathematical Sciences	Associate Professor	KazNRTU n.a. K.I.Satbayev	
Teaching staff of KazNRTU n.a. K.I.Satbayev:				
Ozhikenov K.A.	Candidate of Technical Sciences	Professor, Head of the Department	KazNRTU n.a. K.I.Satbayev	
Teaching staff of KazNMU n.a. S.D. Asfendiyarov:				
Zholdybay Zh.	Doctor of Medical Sciences	Head of the Department of Visual Diagnostics	KazNMU n.a. S.D. Asfendiyarov	
Employers:				
Dzhumagulov A.K.	-	Director	Medremzavod Holding LLP	
Ongarbayev B.T.		Deputy Chairman of the Board for Clinical Work	KaziOR JSC	
Students of KazNRTU n.a. K.I.Satbayev				
Muratov D.M.	-	3 rd year student	KazNRTU n.a. K.I.Satbayev	

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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 educational program "Biomedical Engineering" is aimed at training bachelor professionals in the field of design and construction of medical devices, biotechnical systems by deepening knowledge in 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: The purpose of the educational program is to train highly qualified, competitive and in-demand specialists in the field of biomedical engineering in the labor market, capable of performing design, production, technical, organizational work in professional activities..

Objectives of the EP:

As a result of the training, the bachelor of the "Biomedical Engineering" EP should receive all the necessary knowledge, skills and abilities that ensure the high-quality performance of functional duties in the chosen specialty, as well as acquire socio-humanitarian, economic, organizational and managerial, general scientific and general technical competencies that serve as the foundation for ensuring graduate mobility in the professional labor market and preparedness to continue education in the field of higher or additional education.

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 basics of higher mathematics, physics, chemistry, biology, biophysics, anatomy, physiology to solve professional problems of biomedical engineering.

EO2 - Applies the laws of physics and radiation hygiene to control medical equipment in a clinical setting.

EO3 - Has the skills to use modern software packages for information support of diagnostic and therapeutic processes.

EO4 - Has research skills in the development of new samples and improvement of existing biomedical devices and devices.

EO5 - 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.

EO6 - Operates within the framework of the regulatory framework of the Republic of Kazakhstan in ensuring the safety and quality of disease diagnostics for the design and maintenance of medical equipment.

EO7 - Has the skills to calculate and design modern and reliable blocks and devices.

EO8 - Has the skills of planning tests of modules and subsystems of biomedical technology, organizing and conducting experimental research.

EO9 - Carries out repair, verification and maintenance of professional and household biomedical equipment.

EO10 - Has skills in organizing business processes and making organizational and managerial decisions.

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 and 6B101 Healthcare
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 to train highly qualified, competitive and in-demand specialists in the field of biomedical engineering in the labor market, capable of performing design, production, technical, organizational work in professional activities.
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:	PC1- PC10
12	Learning outcomes of the educational program:	EO1-EO10
13	Form of training	full-time
14	Period of study	4 year
15	Volume of the credits	240
16	Language of education	russian, kazakh
17	The awarded academic degree	Bachelor of Engineering and Technology in the educational program «6B07114 Biomedical Engineering» KazNRTU named after K.I.Satbayev; Certificate with transcript of KazNMU named after S.D. Asfendiyarov

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														
Component of choice														
1.	Fundamentals of anti-corruption culture and law	The course introduces students to the improvement of socio-economic relations of Kazakhstan society, psychological features of corrupt behavior. Special attention is paid to the formation of an anti-corruption culture, legal responsibility for acts of corruption in various spheres. The purpose of studying the discipline «Fundamentals of anti-corruption culture and law» is to increase public and individual legal awareness and legal culture of students, as well as the formation of a knowledge system and a civic position on combating corruption as an antisocial phenomenon. Expected results: to realize the values of moral consciousness and follow moral norms in everyday practice; to work on improving the level of moral and legal culture; to use spiritual and moral mechanisms to prevent corruption.	5											v
2.	Fundamentals of scientific research methods	The main objectives of the academic discipline "Fundamentals of scientific research methods" is to form ideas about the methodological side of knowledge, using the concepts and principles of logic and dialectics, as well as to form students' knowledge and understanding of the methodology of scientific research; to teach how to draw up the structure of future scientific work; to teach the correct formulation of goals, setting goals; to teach the definition of the object and subject of research; to master the competent selection of scientific research methods	5					v						
3.	Fundamentals of economics and entrepreneurship	Discipline studies the foundations of economics and entrepreneurial activity from the point of view of science and law; features, problematic aspects and development prospects; the theory and practice of entrepreneurship as a system of economic and organizational relations of business structures; The readiness of entrepreneurs for innovative susceptibility. The discipline reveals the content of entrepreneurial activity, the stages of career, qualities, competencies and responsibility of the entrepreneur, theoretical and practical business planning and economic examination of business ideas, as well as the analysis of the risks of innovative development, the introduction of new technologies and technological solutions.	5											v
4.	Ecology and life safety	The discipline studies the tasks of ecology as a science, environmental terms, the laws of the functioning of natural systems and aspects of environmental safety in the conditions of labor activity. Monitoring of the environment and management in the field of its safety. Sources of pollution of atmospheric air, surface, groundwater, soil and ways to solve environmental problems; life safety in the technosphere; natural and man-made emergencies	5						v					
Cycle of basic disciplines														
University component														
5.	Automatics	The discipline is aimed at training specialists for: the correct operation of	5										v	

		automatic control systems for the parameters of various technological processes; solving problems associated with various production conditions; study of advanced domestic and foreign experience in the field of production automation. When studying the discipline, students learn to calculate the main indicators of quality, reliability and technical and economic efficiency of automatic control systems.												
6.	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				
7.	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				
8.	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								
9.	Engineering and computer graphics	The discipline is aimed at the study of methods for the image of objects and the general rules of drawing, using computer graphics; the study of the basic principles and geometric modeling approach and methodology for developing applications with a graphical interface; the formation of skills in the use of graphic systems for the development of drawings, using 2D and 3D modeling methods	5								v			
10.	Integral and microprocessor 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	4		v									
11.	Mathematics I	The course is devoted to the study of the basic concepts of higher mathematics and its applications. The main provisions of the discipline are applied in the teaching of all general education engineering and special disciplines taught by graduate departments. The course sections include elements of linear algebra and analytical geometry, an introduction to analysis, differential calculation of functions of one and several variables. Methods for solving systems of equations, problems of using vector calculations in solving problems of geometry, mechanics, and physics are considered. Analytical geometry on a plane and space, differential calculation of functions of one variable, derivatives and differentials, study of the behavior of functions,	5		v									

		derivative and gradient in direction, extremum of a function of several variables.												
12.	Mathematics II	The discipline is a continuation of Mathematics I. sections of the course include integral calculus of a function of one variable and several variables, series theory. Indefinite integrals, their properties and methods of their calculation. Certain integrals and their application. Incorrect integrals. Numerical series theory, functional series theory, Taylor and Macloren Series, application of series to approximate calculations.	6	v										
13.	Mathematics III	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									
14.	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				
15.	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			
16.	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									
17.	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									
18.	Fundamentals of Human Biology	The discipline is aimed at studying the nature of man as a biological being, the 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.	5		v									
19.	Fundamentals of	The discipline is aimed at using the basics of engineering in medicine and	5		v					v				

	diagnostics of internal diseases	methods of using medical equipment in clinical practice; studying methods of application and implementation of medical technologies to optimize the provision of medical services.																	
20.	Basics of information-measuring technology	The discipline is aimed at familiarizing students with the basics of modern information and measurement technologies and their practical application in biomedical engineering; studying methods of obtaining and transmitting biomedical information, models of measuring channels and signals, with their main characteristics; signal processing methods and measurement results	5	v															
21.	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															
22.	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															
23.	High-level Programming	The discipline is aimed at familiarizing with the basics of algorithmization and programming, as well as their main provisions; studying the rules for constructing algorithms; studying the high-level programming language C++ / Python, studying the principles of the modular approach in programming; studying the methods of designing and verifying programs	5			v													
24.	Physics I	Objectives: to study the basic physical phenomena and laws of classical, modern physics; methods of physical research; the relationship of physics with other sciences. The following topics are considered: mechanics, dynamics of rotational motion of a solid body, mechanical harmonic waves, fundamentals of molecular kinetic theory and thermodynamics, transport phenomena, continuum mechanics, electrostatics, direct current, magnetic field, Maxwell equations.	5	v															
25.	Physics II	The course studies the laws of physics and their practical application in professional activity. Solving theoretical and experimental-practical educational problems of physics for the formation of the foundations in solving professional problems. Assessment of the degree of accuracy of the results of experimental or theoretical research methods, modeling of physical condition using a computer, study of modern measuring equipment, development of skills for conducting test studies and processing their results, distribution of the physical content of applied tasks of the future specialty.	5	v															
Cycle of basic disciplines																			
Component of choice																			
26.	Databases of medical systems	The purpose of studying the discipline is to form students' general concepts of database systems in the creation of medical information systems, database system architecture; concepts of relational model, basic elements of the standard relational SQL language; the ability to create a real database; the ability to work in a network or local database.	4			v													
27.	Database design	The discipline is aimed at studying general concepts of database systems	4			v									v				

	technologies	within the framework of mastering disciplinary competencies for the development and design of control systems in robotics: architecture of database systems; concepts of relational model, the main elements of the standard relational SQL language.																
Cycle of profile disciplines																		
University component																		
28.	Methods for processing and analyzing biomedical signals and data	The discipline is aimed at forming a general understanding of the current state and prospects for the development of methods and algorithms for digital processing and analysis of biomedical signals and data used in modern biomedical technology; studying the basics of the theory of biomedical signals; studying the principles of constructing algorithms for processing biomedical signals and data; acquiring skills in processing biomedical signals.	6			v												
29.	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.	4										v					
30.	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														
Cycle of profile disciplines																		
Component of choice																		
31.	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													
32.	Database security of medical systems	"Database security of medical systems" is aimed at studying the general concepts of database security in medical information systems: the architecture of database security systems; the concepts of the relational model, the basic elements of the standard relational SQL language; the ability to create protection of a real database; the ability to work in a network or local database, the study of the principles of building basic data models and their use in modern database management systems (DBMS), the study of methods of protection and security of databases.	5									v	v					
33.	Biofluids	The purpose of mastering the discipline "Bioliuids" is the study of biological and physiological fluids of the human body. The discipline is aimed at the study of biological fluid - a fluid produced by the body itself. The study of the types of biological fluid will allow students to better master the	5	v														

		biomechanism of the flows of biological fluids in organs and tissues, understand the structure of the body at the tissue level, simulate the functioning of the lymphatic, cardiovascular, urinary systems												
34.	Biomechanics	The discipline is aimed at familiarization with the biological basis of mechanics; the study of various levels of organization of living matter: biological macromolecules, cells, tissues, organs, organ systems, as well as whole organisms; the study of animal and human movements, mechanical phenomena in tissues, organs and systems; the study of deformations in biosystems associated with biological processes.	5	v										
35.	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	v								
36.	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										
37.	Modeling of dynamic systems	The discipline is aimed at studying the principles of constructing simulation modeling of dynamic systems on MATLAB/SIMULINK and analyzing the flow of dynamic processes in robot drives and evaluating the positioning process indicators, as well as simulation methods for building control systems of mechatronic and robotic systems.	5				v				v			
38.	Orthopedic Biomechanics	The discipline "Orthopedic Biomechanics" is aimed at training a general practitioner who has deep 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, the study of the theoretical and methodological foundations of the specialty, the formation of practical skills and abilities for the diagnosis, treatment and prevention of injuries of the musculoskeletal system, orthopedic diseases.	5		v	v								
39.	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										
40.	Inspection and testing of medical equipment	The discipline of "Inspection and testing of medical equipment" is aimed at the formation of students' knowledge about the operation and maintenance of medical devices, biotechnical systems and devices in terms of biomedical organizations, training principles to ensure the conditions of safe activity during development manufacture and operation of biomedical devices,	5								v		v	

		packages and systems, learning the ways of applying the methods of organization of routine maintenance, calibration and certification of medical equipment.												
41.	CAD of biotechnical and medical systems	The discipline is aimed at mastering the basic principles of development and design of various types of electronic medical devices, devices and systems. Acquisition of skills to substantiate technical requirements for devices, devices and systems used in medical practice; ability to perform calculations of the main components of devices, devices and systems using modern software; to coordinate the parameters of devices, devices and systems for therapy, diagnostics and surgery with the parameters of a biological object.	5								v			
42.	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									
43.	Standardization and technical measurements	The discipline is aimed at students' acquisition of scientific knowledge, as well as skills in applying methods and practical fundamentals of standardization, and technical measurements in the design of equipment, devices, mechatronic and robotic complexes, the development of standards, as well as the calculation of errors of electronic equipment.	5									v	v	
44.	Stereolithographic biomodeling in medicine	The discipline is aimed at studying a new technology of rapid prototyping of medical devices, the technology of layer-by-layer manufacturing of a plastic copy of an object according to its computer three-dimensional image, using laser radiation and liquid photopolymerizing compositions. Study of methods of modeling and refinement of medical devices in computer programs for 3D printing	5								v			
45.	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								
46.	Control 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.	6								v			
47.	Capstone research project 1	The course will allow students to learn how to transform an idea into a concrete solution and determine the most optimal approach to its implementation. The course participants will gain a holistic understanding of the process, key techniques and tools necessary for the design, development and further development of their products and services. As a result, students will get acquainted with the methods of rapid design of prototype solutions, learn how to plan the stages of work on the product and evaluate their labor intensity, will be able to find non-standard solutions to take into account the	5				v							

		specific conditions of the tasks performed and develop innovative solutions.											
48.	Capstone research project 2	The Capstone Research Project 2 course is a continuation of the Capstone Research Project 1 course. The course "Capstone research project 2" is an independently completed development related to the solution of theoretical issues and experimental research or to the solution of applied problems that are part of the research work carried out by the department or enterprise.	5							v	v		

5. Curriculum of educational program

KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I.SATPAYEV
KAZAKH NATIONAL MEDICAL UNIVERSITY named after S.D. ASFENDIYAROV

APPROVE

**Chairman of the Management Board -
 Rector of KazNMU named after S.D.
 Asfendiyarov
 M.E. Shoranov**

« ____ » _____ 2023 y.

APPROVED

**Chairman of the Management Board-
 Rector of Kazntu named after K.Satpayev**

_____ M.M. Begentaev

« ____ » _____ 2023 y.

CURRICULUM

of Educational Program on enrollment for 2023-2024 academic year
 Educational program 6B007114 - "Biomedical engineering"
 Group of educational programs B063 - "Electrical engineering and automation"

Form of study: full-time

Duration of study: 4 years

Academic degree: Bachelor of Engineering and Technology

Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	Classroom amount lec/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters							
								I course		II course		III course		IV course	
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester	7 semester	8 semester
M-1. Module of language training															
LNG 108	Foreign language	GED, RC	10	300	0/0/6	210	E	5	5						
LNG 104	Kazakh (Russian) language	GED, RC	10	300	0/0/6	210	E	5	5						
M-2. Module of physical training															
KFK 101-104	Physical Culture	GED, RC	8	240	0/0/8	120	Difcredit	2	2	2	2				
M-3. Module of information technology															
CSE 677	Information and communication technologies (in English)	GED, RC	5	150	2/1/0	105	E			5					
GEN 429	Engineering and computer graphics	BD, UC	5	150	1/0/2	105	Э		5						
M-4. Module of socio-cultural development															

HUM 137	History of Kazakhstan	GE D, RC	5	150	1/0/2	105	SE	5								
HUM 132	Philosophy	GE D, RC	5	150	1/0/2	105	E						5			
HUM 120	Socio-political knowledge module (sociology, politology)	GE D, RC	3	90	1/0/1	60	E			3						
HUM 134	Socio-political knowledge module (culturology, psychology)		5	150	2/0/1	150	E				5					
M-5. Module of anti-corruption culture, ecology and life safety base																
HUM 136	Fundamentals of anti-corruption culture and law	GE D, CC H	5	150	2/0/1	150	E						5			
MNG 489	Fundamentals of Economics and Entrepreneurship															
ELC577	Fundamentals of scientific research methods															
CHE 656	Ecology and life safety															
M-6. Mathematical training module																
MAT 101	Mathematics I	BD, UC	5	150	1/0/2	105	E	5								
MAT 102	Mathematics II	BD, UC	5	150	1/0/2	105	E		5							
MAT 103	Mathematics III	BD, UC	5	150	1/0/2	105	E			5						
M-7. Module of basic training																
PHY 111	Physics I	BD, UC	5	150	1/1/1	105	E	5								
CHE846	General chemistry	BD, UC	4	120	1/1/1	75	E	4								
PHY 112	Physics II	BD, UC	5	150	1/1/1	105	E		5							
M-8. Human Biology Module																
ROB600	Fundamentals of Human Biology	BD, UC	5	150	2/0/1	105	E			5						
ROB601	Biophysics	BD, UC	5	150	2/1/0	105	E			5						
ROB602	Fundamentals of human anatomy	BD, UC	5	150	1/1/1	105	E				5					
ROB603	Fundamentals of human physiology	BD, UC	5	150	2/1/0	105	E				5					
M-9. Electronics and Circuit Engineering module																

ROB538	Fundamentals of electromechanics and electronics	BD, UC	6	180	2/1/1	120	E				6				
ROB572	Biomedical electronics	BD, UC	5	150	1/1/1	105	E				5				
ROB573	Integrated and microprocessor circuitry	BD, UC	5	150	2/1/0	105	E					5			
M-10. Biomechanics Module															
ROB413	Biomechanics	BD, EC	5	150	2/0/1	105	E					5			
ROB414	Orthopedic biomechanics														
ROB569	Thermodynamics of biological systems	PD, UC	4	120	1/1/1	75	E						4		
ROB531	Bio - liquids	PD, EC	5	150	2/1/0	105	E							5	
ROB593	Database security of medical systems														
M-11. Programming module and databases															
ROB504	Programming in a high level language	BD, UC	5	150	2/1/0	105	E					5			
ROB597	Database design technologies	BD, EC	4	120	2/1/0	75	E						4		
ROB598	Databases of medical systems														
ROB550	Programming for engineers with MATLAB	PD, UC	4	120	1/1/1	75	E							4	
M-12. Measurement and processing module															
ROB187	Fundamentals of information and measurement technologies	BD, UC	5	150	2/1/0	105	E					5			
ROB605	Fundamentals of medical optics	PD, EC	4	120	1/1/1	75	E						4		
ROB606	Sensors in medicine				2/1/0										
ROB568	Methods for processing and analyzing biomedical signals and data	PD, UC	6	180	1/1/2	120	E							6	
M-13. Control module															
ROB514	Automation	BD, UC	5	150	2/0/1	105	E						5		
ROB534	Mechanics of controlled machines	BD, UC	5	150	2/0/1	105	E							5	
ROB609	Management in biotechnical systems	PD, EC	6	180	2/1/1	120	E								6
ROB610	Machine learning theory and neural networks				1/1/2										
M-14. Biomedical Engineering Module															

ROB412	Biomedical engineering	BD, UC	5	150	2/0/1	105	E					5					
ROB565	Artificial life support equipment	PD, EC	6	180	1/1/2	120	E									6	
ROB566	Biotechnical and medical diagnostic equipment																
ROB417	Inspection and testing of medical equipment	PD, EC	5	150	2/1/0	105	E										5
ROB567	Cardiotechnics				1/1/1												
M-15. Clinical Engineering Module																	
ROB599	Basics of diagnosis of internal diseases	BD, UC	5	150	0/0/3	105	E						5				
ROB604	Medical imaging	BD, UC	5	150	0/0/3	105	E							5			
M-16. R&D Module																	
ROB415	Stereolithographic biomodeling in medicine	PD, EC	5	150	2/0/1	105	course project									5	
ROB540	Capstone research project 1				0/0/3												
ROB135	CAD of biotechnical and medical systems	PD, EC	5	150	2/1/0	105	course project										5
ROB541	Capstone research project 2				0/0/3												
ROB595	Modeling of dynamic systems	PD, EC	5	150	2/0/1	120	E										5
ROB596	Standardization and technical measurements																
M-17. Practice module																	
AAP179	Educational practice	BD, UC	2									2					
AAP143	Production practice I	PD, UC	2										2				
AAP193	Production practice II	PD, UC	3												3		
M-18. Module of final attestation																	
ECA108	Final examination	FA	8														8
M-19. Module of additional types of training																	
AAP500	Military affairs	ATT	0														
Total based on UNIVERSITY:									31	29	31	29	30	30	31	29	
									60	60	60	60	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		5	56
BD	Cycle of basic disciplines		107	4	176
PD	Cycle of profile disciplines		19	46	
	Total for theoretical training:	51			232
FA	Final attestation	8			8
	TOTAL:	59	0	0	240

Decision of the Academic Council of KazNRTU named after K.Satpayev. Protocol no. ___ from "___" ____20__ y.

The decision of the Academic Council of KazNMU named after S.D. Asfendiyarov. Protocol no. ___ from "___" ____20__ y.

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Protocol no. ___ from "___" ____20__ y.

The decision of the Academic Council of KazNMU named after S.D. Asfendiyarov. Protocol no. ___ from "___" ____20__ y.

Decision of the Academic Council of the Institute of A&IT. Protocol no. ___ from "___" ____20__ y.

Decision of the Academic Council of the School of General Medicine _____. Protocol no. ___ from "___" ____20__ y.

Vice-Rector for Academic Affairs _____

B.A. Zhautikov

Vice-Rector of KazNMU named after S.D.Asfendiyarov _____

K.J. Bayldinova

Director of the Institute of Automation and Information Technology _____

R.K. Uskenbayeva

Head of the Department of Robotics and Automation Equipment _____

K.A. Ozhikenov

Dean of the School of General Medicine _____

S.H. Izmailova

Specialty Council representative from employers _____

A.K. Dzhumagulov

