

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

APPROVED

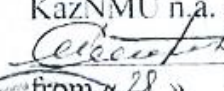
Chairman of the Board – Rector
KazNRTU n.a. K.I.Satbayev


M.M. Begentayev
from «04» 05 2024y.



APPROVED

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


M.E. Shoranov
from «28» 04 2024y.



**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 2024

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

JEP Developers

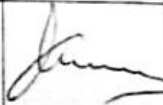
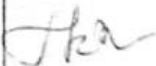
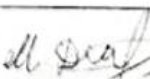
Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairman of the Academic Committee of KazNRTU n.a. K.I.Satbayev:				
Baktybaev M.K.	Candidate of Physical and Mathematical Sciences	Associate Professor	KazNRTU n.a. K.I.Satbayev	
Teaching staff of KazNRTU n.a. K.I.Satbayev:				
Ozhikenov 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 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 - 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.

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 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													
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,	5										

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		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.												
7.	Socio-political knowledge module (sociology, politology)	The objectives of the disciplines are to provide students with explanations on the 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.	3											
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	To form an informed understanding of the problem of corruption in society, to develop anti-corruption skills, as well as to educate civic responsibility and ethical principles. Contents_ basic theoretical and practical knowledge about corruption, analysis of corruption phenomena, strategies and methods of combating them, formation of adequate behavior and values aimed at creating an honest and open society	5						v					
10.	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	5								v			

		research; to master the competent selection of scientific research methods												
11.	Fundamentals of economics and entrepreneurship	The purpose of studying the discipline is to familiarize students with the basic principles of economic theory and entrepreneurial activity. The course includes the study of basic economic concepts, market mechanisms, management tools and key aspects of entrepreneurship, such as starting and managing a business, analyzing the market environment, financial planning, assessing risks and developing development strategies.	5					v						
12.	Ecology and life safety	The purpose of the discipline: to acquaint students with the tasks of ecology as a science, its sections and conclusions that find application in various fields of practical activity. Brief description: ecological terms, laws of functioning of natural systems are considered; environmental monitoring and management in the field of its security; sources of air, water, soil pollution and ways to solve environmental problems; emergency situations of natural and man-made nature.	5				v							
13.	Basics of Financial Literacy	Purpose: acquiring knowledge and skills in the field of personal finance management, including budget planning, use of financial instruments, taxation and investments to ensure effective management and increase of own funds. Contents: as part of the course, students will master the basics of financial management, learn how to create a budget, use various financial products, plan and pay taxes. They will also gain practical skills in analyzing financial information and choosing investment strategies.	5					v				v		
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	5	v						v				

		developed.											
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: formation of knowledge of drawing construction, skills to read and develop graphic documentation. The student must apply the achievements of modern computer technology in all areas of the transport industry. Contents_ ESCD standards. Graphic primitives. Methods and properties of orthogonal projection. The Monge plot. GOST 2.305-68. Incisions. Axonometric projections. Types of connections. Polyhedra. Sketches of details. Detailing. Ways to transform a drawing. Creating a 3D complex solid-state object in the AutoCAD system	5									v	
19.	Integral and microprocessor	The discipline is aimed at familiarizing students with the basics of digital integrated circuitry and their practical application in	4							v			

	circuit design	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											
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	6						v				
22.	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				
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	5	v			v						

		its risks in achieving the best results for the patient within the framework of technical professional activity											
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 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				
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	The purpose of the discipline is to study general information	5						v				

	information-measuring technology	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.											
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	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				
34.	Physics II	The course studies the laws of physics and their practical	5						v				

		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.											
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.											
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. Contents: The discipline covers the basics of IP law, including copyright, patents, trademarks, and industrial designs. Students learn how to protect and manage intellectual property rights, and consider legal disputes and methods for resolving them.	5				v						
38.	Fundamentals of sustainable development and	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	5				v						

	ESG projects in Kazakhstan	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.											
39.	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	
40.	Fundamentals of Artificial Intelligence	The purpose of the course is to familiarize students with the basic concepts, methods and technologies in the field of artificial intelligence: machine learning, computer vision, natural language processing, etc. As a result of studying this course, students will gain an understanding of the basic principles of artificial intelligence systems and their role in the modern world. The purpose of this course is to provide an introduction to the basic concepts, methods, and technologies of artificial intelligence, such as machine learning, computer vision, natural language processing, and others. Students will acquire knowledge of the key principles, algorithms and practical applications that underlie the development and use of artificial intelligence in various fields. Upon completion of the course, students achieve the following learning outcomes: Know basic machine learning techniques, including supervised, unsupervised and reinforcement learning; be able to apply machine learning methods to solve various problems; have skills in working with various artificial intelligence tools and technologies.	5								v		v
41.	Management in biotechnical systems	The discipline is aimed at the formation of knowledge on the theory of automatic control and various methods of optimizing	4										v

		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.											
42.	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.	4									v	
Cycle of profile disciplines University component													
43.	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	
44.	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													
45.	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	6	v						v			

		equipment, engineering research methods to solve various problems of medicine.											
46.	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
47.	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			
48.	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						v			
49.	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, packages and systems, learning the ways of applying the methods of organization of routine maintenance, calibration and certification of medical equipment.	5			v	v						

50.	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				
51.	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
52.	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		
53.	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 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.	5	v					v				
54.	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	5	v								v	

		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.											
55.	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				
56.	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									
57.	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	
58.	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		
59.	Processing and	Purpose: formation of competencies in the field of methods and	6	v								v	

	analysis of biomedical signals and data	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.											
60.	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 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.	6									v	
61.	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						
62.	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						



Chairman of the Management Board
Rector of Krasnodar State University
M.E. Shoranny

23 24 2024

CURRICULUM
of Educational Program on enrollment for 2024-2025 academic year
Educational program 6B007114 - "Biomedical engineering"
Group of educational programs B063 - "Electrical engineering and automation"



Chairman of the Management Board
Director of KazNRTU named after K. Satpayev
M.M. Begentayev
2023 April 2024

21 April 2024

Academic degree: Bachelor of Engineering and Technology				All allocation of hours, for training based on courses and semesters				Allocation of hours for training based on courses and semesters					
Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	Classroom amount (lect/pr)	SSS (including TSS) in hours	Form of control	Course					
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester
M-1. Module of language training													
LNG 108	Foreign language	GED, RC	5	150	0/0/3	105	E	5					
LNG 108	Foreign language	GED, RC	5	150	0/0/3	105	E		5				
LNG 104	Kazakh (Russian) language	GED, RC	5	150	0/0/3	105	E	5					
LNG 104	Kazakh (Russian) language	GED, RC	5	150	0/0/3	105	E		5				
M-2. Module of physical training													
EFK 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	GED, RC	5	150	2/1/0	105	E			5			
GEN 429	Engineering and computer graphics	BD, UC	5	150	1/0/2	105	E		5				
M-4. Module of socio-cultural development													
HUM 137	History of Kazakhstan	GED, RC	5	150	1/0/2	105	SE	5					
HUM 132	Philosophy	GED, RC	5	150	1/0/2	105	E				5		
HUM 120	Socio-political knowledge module (sociology, politicalology)	GED, RC	3	90	1/0/1	60	E			3			
HUM 134	Socio-political knowledge module (culturalology, psychology)	GED, RC	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												
MNG 489	Fundamentals of Economics and Entrepreneurship	GED, COH	5	150	2/0/1	150	E				5		
ELC 577	Fundamentals of scientific research methods												
CHE 656	Ecology and life safety												
MNG 564	Basics of Financial Literacy												
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					
CHE 846	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													
ROB 600	Fundamentals of Human Biology	BD, UC	5	150	1/0/2	105	E			5			
ROB 601	Biophysics	BD, UC	5	150	1/0/2	105	E			5			
ROB 602	Fundamentals of human anatomy	BD, UC	5	150	1/0/2	105	E				5		
ROB 603	Fundamentals of human physiology	BD, UC	5	150	1/0/2	105	E				5		
M-9. Electronics and Circuit Engineering module													
ROB 538	Fundamentals of electromechanics and electronics	BD, UC	6	180	2/1/1	120	E			6			
ROB 572	Biomedical electronics	BD, UC	5	150	1/1/1	105	E				5		
ROB 573	Integrated and microprocessor circuitry				2/1/0/								
MNG 562	Legal regulation of intellectual property	BD, EC	5	150		105	E				5		
MNG 563	Fundamentals of sustainable development and ESG projects in Kazakhstan				2/0/1								
M-10. Biomechanics Module													
ROB 611	Engineering biomechanics	BD, EC	5	150	1/0/2	105	E				5		
ROB 612	Orthopedic biomechanics												
ROB 569	Thermodynamics of biological systems	PD, UC	4	120	1/1/1	75	E					4	
ROB 613	Bio - liquids	PD, EC	5	150	1/0/2	105	E						5
ROB 614	Biomaterials												
M-11. Programming module													
ROB 650	Programming for microcontrollers												
ROB 615	Programming in a high-level language	BD, EC	5	150	1/1/1	105	E				5		
CSE 831	The basics of artificial intelligence				1/0/2								
ROB 528	Programming for engineers with MATLAB	PD, UC	5	150	1/0/2	105	E						5
M-12. Measurement and processing module													
ROB 187	Fundamentals of information and measurement technologies	BD, UC	5	150	2/1/0	105	E					5	
ROB 619	Metrological support of measuring sensory information	PD, EC	4	120	1/0/2	75	E					4	
ROB 620	Processing and analysis of biomedical signals and data												6
ROB 621	Processing of biomedical images	PD, EC	6	180	1/1/2	120	E						
M-13. Control module													
ROB 622	The theory of automatic control	BD, UC	5	150	1/1/1/	105	E					5	
ROB 534	Mechanics of controlled machines	BD, UC	5	150	2/0/1	105	E						5
ROB 609	Management in biotechnical systems				2/1/1								6
ROB 610	Machine learning theory and neural networks	PD, EC	6	180	1/1/2	120	E						
M-14. Biomedical Engineering Module													
ROB 412	Biomedical engineering	BD, UC	5	150	2/0/1	105	E				5		
ROB 565	Artificial life support equipment												
ROB 566	Biotechnical and medical diagnostic equipment	PD, EC	6	180	1/1/2	120	E					6	
ROB 605	Fundamentals of medical optics	PD, EC	4	120	1/1/1	75	E						4
ROB 606	Sensors in medicine				2/1/0								
ROB 417	Inspection and testing of medical equipment	PD, EC	5	150	2/1/0	105	E						5
ROB 567	Cardiotechnics				1/1/1								
M-15. Clinical Engineering Module													
ROB 599	Basics of diagnosis of internal diseases	BD, UC	5	150	0/0/3	105	E					5	
ROB 604	Medical imaging	BD, UC	5	150	0/0/3	105	E						5
ROB 545	Microcontroller control systems				1/1/1							4	
ROB 617	Machine learning for biomedical	BD, EC	4	120	1/0/2	75	E						
M-16. R&D Module													
ROB 634	Design in cardiology												
ROB 635	Designing in orthopedies	PD, EC	5	150	0/0/3	105	course project						5
ROB 636	Modeling in biomechanics	PD, EC	5	150	1/1/1	105	course project						5
ROB 637	Statistical modeling of systems												
M-17. Practice-oriented module													
AAP 173	Educational practice	BD, UC	2						2				
AAP 102	Production practice I	PD, UC	2							2			
AAP 183	Production practice II	PD, UC	3								3		

