



**Institute of Automation and Information Technology  
Department “Robotics and Engineering Tools of Automation”**

**EDUCATIONAL PROGRAM  
6B07114 Biomedical Engineering**

Code and classification of the field of education:

**6B07** Engineering, manufacturing and construction industries

Code and classification of training directions:

**6B071 Engineering and engineering trades**

Group of educational programs:

**B063 Electrical engineering and automation**

Level based on NQF: **6**

Level based on IQF: **6**

Study period: **4 year**

Amount of credits: **240**

**Almaty 2022**

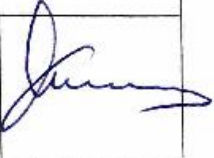
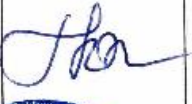



Educational program 6B07114 Biomedical Engineering was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes #13 dated 28.04.2022

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

Minutes #7 dated 26.04.2022

Educational program 6B07114 Biomedical Engineering was developed by Academic committee based on direction 6B071 Engineering and engineering trades.

Full name	Academic degree/ academic title	Position	Workplace	Signature
<b>Chairperson of Academic Committee:</b>				
Baktybaev Murat Kyrgyzbaevich	Candidate of Physical and Mathematical Sciences	Associate Professor	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	
<b>Teaching staff:</b>				
Ozhikenov Kassymbek Adilbekovich	Candidate of Technical Sciences	Professor, Head of the Department	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	
<b>Employers:</b>				
Dzhumagulov Arystanbek Kuyzembraevich	-	General Director	LLP «MEDREMZAVOD HOLDING»	
Akzhanov Janat Koishibaevich	-	Director	LLP «SAIMAN Corporation»	
<b>Students</b>				
Muratov Dias Muratovich	-	3rd year student	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	

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## **List of abbreviations and designations**

EP - Educational program

GEP - general education disciplines

BD - basic disciplines

PD - profile disciplines

MSHE RK - Ministry of Science and Higher Education of the Republic of Kazakhstan

SAC - state attestation commission

ECTS - European Credit Transfer and Accumulation System

GC – General cultural competences

GPC - General professional competencies

PC - Professional competence

EO - educational outcomes

FA – final attestation

## 1. Description of educational program

The professional activities of the graduates of the program are directed to the field of Biomedical Engineering.

Educational program «Biomedical Engineering» is aimed at training professional bachelors in the field of design and construction of robots, biomedical systems for industrial and non-industrial purposes.

*The objects of professional activity* of graduates who have completed the undergraduate program are biomedical systems, including information and sensory, Executive and control units, their mathematical, algorithmic and software methods and tools for design, modeling, experimental studies, debugging and exploitation, research and production testing of biomedical systems having different applications.

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 SAC confers the academic degree "Bachelor of engineering and technology" in the educational program "Biomedical Engineering" and a state-issued diploma with an Appendix is issued.

Issuance of a state-issued diploma with an Appendix is carried out on the basis of an order of the head of the University on graduation.

The diploma Supplement is filled out on the basis of a certificate of completion of the student's (student's) individual curriculum in accordance with the received grades in all disciplines in the amount provided for by the state mandatory standard of education and the working curriculum, completed course papers (projects), types of practices and the results of final certification.

In the diploma Supplement, 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.

**Tasks of EP:** As a result of the training, the Bachelor of «Biomedical Engineering» 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 readiness for continuing education in the field of higher or additional education.

### Competencies at the end of studying

<b>Generalcultural competences (GC)</b>	
<b>GC 1</b>	The ability to communicate in oral and written forms in the state, Russian and foreign languages for solving problems of interpersonal and intercultural interaction
<b>GC 2</b>	Understanding and practical use of the norms of a healthy lifestyle, including issues of prevention, the ability to use physical culture to optimize performance
<b>GC 3</b>	The ability to analyze the main stages and patterns of the historical development of society for the formation of civic position
<b>GC 4</b>	Ability to use the foundations of philosophical knowledge to form a worldview
<b>GC 5</b>	The ability to critically use the methods of modern science in practice
<b>GC 6</b>	Awareness of the need and the acquisition of the ability to independently study and improve their qualifications throughout their working life
<b>GC 7</b>	Knowledge and understanding of professional ethical standards, mastery of professional communication techniques
<b>GC 8</b>	Ability to work in a team, tolerantly perceiving social, ethnic, confessional and cultural differences
<b>GC 9</b>	Ability to use the basics of economic knowledge in various fields of activity
<b>General professional competencies (GPC)</b>	
<b>GPC 1</b>	Knowledge of design methods for biomedical systems, their individual subsystems and modules
<b>GPC 2</b>	Possession of modern software products for solving problems of system design, design of mechanical and mechatronic modules biomedical systems, control and information processing
<b>GPC 3</b>	Knowledge of mathematical models of biomedical 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
<b>GPC 4</b>	Understanding the physical processes and phenomena underlying the principles of operation of devices, equipment and systems
<b>GPC 5</b>	Knowledge of standards, methodological and regulatory materials accompanying the operation, installation and adjustment of modern biomedical systems with digital control
<b>Professional competence (PC)</b>	
<b>PC -1</b>	Collection and analysis of scientific and technical information, taking into account modern trends in the development and use of the achievements of science,

	technology and technology in professional activities
<b>PC -2</b>	Assessment of the economic efficiency of the implementation of projected biomedical systems, their individual modules and subsystems
<b>PC -3</b>	Application of modern software products and the latest technologies for solving and managing interdisciplinary engineering problems in various fields of science and technology
<b>PC -4</b>	Evaluation of the surrounding reality on the basis of worldview positions formed by knowledge of the foundations of philosophy, which provide scientific understanding and study of the natural and social world by methods of scientific and philosophical knowledge
<b>PC -5</b>	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
<b>PC -6</b>	Planning tests of modules and subsystems of biomedical systems, participation in the organization and conduct of experiments at existing facilities and experimental models, processing the results of experimental studies using modern information technologies
<b>PC -7</b>	Monitoring the compliance of technical documentation of developed projects with standards and technological conditions
<b>PC -8</b>	Implementation of the results of theoretical developments in the production of biomedical systems, their subsystems and individual modules
<b>PC -9</b>	Organization of work on operation, installation and commissioning of modern biomedical systems
<b>PC -10</b>	Organization of the activities of the production team, making organizational and managerial decisions in the context of different opinions and assessing the consequences of decisions made



### **3. Requirements for evaluating the educational program learning outcomes**

**EO1** - Has the skills of demonstrating knowledge of the sections of higher mathematics, physics, chemistry and other natural sciences; applying them to solve problems arising in the course of professional activity.

**EO2** – Uses tools based on physical and physico-chemical methods of studying the characteristics of biological objects for the diagnosis, treatment, rehabilitation and prevention of human diseases, biological experiments.

**EO3** – Has the skills of obtaining and processing biomedical information; creation and operation of medical databases, expert, monitoring systems; use of modern software packages for information support of diagnostic and therapeutic processes.

**EO4** – Possesses research skills in the field of developing new samples and improving existing biomedical devices and devices, searching for new ways to manage technical systems and information processing.

**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** – Has the skills to determine the safety, environmental friendliness, reliability and technical and economic efficiency of biomedical equipment, according to their individual modules and subsystems.

**EO7** – Has the skills of calculating and designing modern and reliable blocks and devices; intelligently controlled executive, sensory-information modules of biomedical technology.

**EO8** – Has the skills of planning tests of modules and subsystems of biomedical technology, organizing and conducting experimental research, processing the results of experimental research.

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

**EO10** - Has skills in organizing business processes; making organizational and managerial decisions in conditions of different opinions and situations of conflict of interests.

## 4. Passport of educational program

### 4.1. General information

№	Field name	Comments
1	Code and classification of the field of education	6B07 Manufacturing and processing industries
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	New
8	The level based on NQF	6
9	The level based on IQF	6
10	Distinctive features of EP	-
11	List of competencies of educational program	providing a wide range of theoretical and practical knowledge in the professional field; the ability to develop methodological and regulatory documents, technical documentation, as well as the implementation of measures for the implementation of developed projects and programs; the ability to make decisions based on the results of calculations on projects and the results of technical, economic and functional cost analysis of the effectiveness of designed biomedical systems; to know the organization of work on operation, installation and commissioning of modern medical equipment
12	Learning outcomes of educational program	EO1-EO10
13	Education form	full-time
14	Period of training	4 year
15	Amount of credits	240
16	Languages of instruction	russian, kazakh
17	Academic degree awarded	«Bachelor of Engineering and Technology in the educational program «6B07114 Biomedical Engineering»
18	Developer(s) and authors	Ozhikenov K.A., Tasbolatova L.T.

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

№	Discipline name	Short description of discipline	Amount of credits	Generated learning outcomes (codes)										
				EO1	EO2	EO3	EO4	EO5	EO6	EO7	EO8	EO9	EO10	
<b>Cycle of general education disciplines</b>														
<b>Component of choice</b>														
1.	Fundamentals of anti-corruption culture	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" 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 Entrepreneurship and Leadership	The discipline studies the basics of entrepreneurship and leadership from the point of view of science and law; features, problematic aspects and prospects of development; theory and practice of entrepreneurship as a system of economic, organizational and legal relations of business structures; readiness of entrepreneurs for innovative receptivity. The discipline reveals the content of entrepreneurial activity, career stages, qualities, competencies and responsibilities of an entrepreneur, theoretical and practical business planning and economic expertise of business ideas, as well as risk analysis of innovative development, introduction of new technologies and technological solutions.	5											v
3.	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				

<b>Cycle of basic disciplines University component</b>													
4.	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		
5.	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, derivative and gradient in direction, extremum of a function of several variables.	5	v									
6.	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.	5	v									
7.	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									
8.	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	5	v									

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		body, mechanical harmonic waves, fundamentals of molecular kinetic theory and thermodynamics, transport phenomena, continuum mechanics, electrostatics, direct current, magnetic field, Maxwell equations.												
9.	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										
10.	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										
11.	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										
12.	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									
13.	Integrated and microprocessor circuitry	The discipline is aimed at familiarizing students with the basics of digital integrated circuitry and their practical application in robotics, getting an idea of the development of integrated digital circuitry, architecture and programming of typical microprocessor systems, methods of automated modeling and design of electronic circuits.	5		v									
14.	Programming in a high level language	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	5			v								

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		of the modular approach in programming; studying the methods of designing and verifying programs.											
15.	Fundamentals of information and measurement technologies	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								
16.	Automation	The discipline is aimed at training specialists for: the correct operation of 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.	5							v			
17.	Control in biotechnical systems	The discipline is aimed at the formation of knowledge on the theory of automatic control and various ways 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; the study of adaptive automated control systems of electric drives of biotechnical systems; the study of intelligent control systems and their application in biotechnical systems.	5							v			
18.	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		v			
19.	Fundamentals of research methodology	The discipline "Fundamentals of research methodology" is aimed at studying the theory of methodology and methods of scientific and pedagogical research, the use of this knowledge in the specific research work of students. To acquaint students with the basic concepts of the general methodology of cognition of objective reality; to study the features of the subject of scientific research. When conducting training sessions on the discipline, the development of students' skills of teamwork, interpersonal communication is ensured.	5					v					

<b>Cycle of basic disciplines</b>													
<b>Component of choice</b>													
20.	Human anatomy	The discipline is aimed at studying the anatomical structure of human organs and systems, both by age and by gender. Disclosure of the characteristic features and variability of anatomical structures, taking into account the impact of temporary factors. The study of the topographic features of organs and systems will allow students to better understand the processes of interaction of systems, the biomechanism of the work of organs and systems as a whole organism.	3	v									
21.	Anatomy with biomedical application	The discipline studies the basic principles of the structure of the human body, the physiological mechanisms of organs and systems. The study of the discipline is aimed at mastering the basics of medicine in technical universities and provides systematic knowledge about the physiological processes of the human body. Disclosure of the physiological properties of organs and systems separately and as an integral organism, the structural features of the musculoskeletal system, the musculoskeletal system of man. Familiarization with pathological processes, capabilities and features of the limited state of the musculoskeletal system, injuries. Study of methods of medical care.	3	v	v								
22.	Human biology	The discipline is aimed at studying the human natural environment as a biological being, the processes of human life, its organs and tissues. The study of "Human Biology" will allow students to better master the morphological, physiological features of the structure of the human body, the external and internal adaptation of the structure, the laws of the body and the relationship with the environment.	4	v									
23.	Physiology with biomedical application	The discipline is aimed at studying the vital activity of a living organism as a whole, its interaction with the environment, the dynamics of life processes in the natural environment. The study of the mechanisms of functional activity and the laws by which functions and processes are carried out in a living being at various levels of its organization as a biological system.	4	v									
24.	Fundamentals of 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									

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25.	Biomechanics Engineering	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								
26.	Physics of the human body	The discipline is aimed at studying the applicability of the laws of physics in the work of the human body; the study of the characteristics of the human body from the point of view of the laws of physics; the study of human mechanical parameters, vibrations and waves in living organisms; the study of thermal processes in the human body and electrical properties of the human body; the study of human optical parameters; the study of the effects of artificial intelligence and nanotechnology on the work of the body human.	6	v	v								
27.	Biomedical physics	The purpose of mastering the discipline is to 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 at the molecular level of the physical and biophysical mechanisms of the most important processes underlying the functioning of the human body; 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; getting ideas about modern physical methods of diagnosis and therapy and scientific research in medicine.	6		v								
28.	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.	7								v		
29.	Intelligent information and measurement systems	The discipline is aimed at studying the principles of construction and organization of intelligent measuring instruments, methods of using software, to have an idea of the methods of intellectualization of measuring instruments, the features of the software and hardware parts of intelligent systems and software and hardware complexes, the features of the components of information intelligent systems and software used in intelligent systems.	7			v	v				v		
<b>Cycle of profile disciplines University component</b>													



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30.	Biofluids	The purpose of mastering the discipline "Bioliquids" 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 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.	5	v											
31.	Programming for engineers with MATLAB	The discipline is aimed at studying typical mathematical schemes for modeling systems, familiarizing with the main approaches to simulating systems, studying modern methods of simulating physical control processes in devices, in technical means of automation and technological processes in the MATLAB environment.	5									v			
32.	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	v							
33.	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											
<b>Cycle of profile disciplines Component of choice</b>															
34.	Solid Biomechanics	The discipline is aimed at a comprehensive study of solid-state mechanical devices of biological organisms. Familiarity with the world of construction mechanics and a variety of mechanical devices that connect such dissimilar creatures as bacteria, plants and animals. A wide range of topics is studied in depth, from spider silk and shark skin to climbing plants and human food processing. The bodies of animals and plants are studied, which are masterpieces of engineering, allowing them to survive in a cruel world.	7	v											

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35.	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.	7		v	v								
36.	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 of solving optical problems; the principles of operation and the device of modern experimental equipment for the study of optical phenomena and matter using optical methods.	7	v										
37.	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, as well as the principles of testing and legal aspects of the development of biomedical devices.	7		v					v				
38.	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.	7		v									
39.	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.	7		v	v								
40.	Clinical Engineering	The discipline is aimed at mastering 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;	8		v	v								

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		studying the theory and methods of assessing the functionality of medical equipment; studying the causes and ways to eliminate breakdowns of medical equipment.											
41.	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.	8		v	v							
42.	Medical imaging	The discipline is aimed at studying the basic physical and engineering principles underlying the main methods of medical imaging, and their relative advantages and disadvantages will be considered. The possibilities of visualization methods will be explained in terms of performance criteria such as spatial and temporal resolution, contrast and signal-to-noise ratio.	8		v	v							
43.	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.	8						v			v	
44.	Statistical methods in engineering research	The discipline is aimed at studying the basic methods of modeling processes and systems in solving problems of processing and interpretation of experimental data and problems of system engineering and circuit design, the formation of logical and algorithmic thinking of students, allowing the use of statistical methods in engineering research.	6			v						v	
45.	Fundamentals of engineering creativity	The discipline is aimed at studying the basics of the theory of technical creativity and methods of solving engineering problems that arise in the process of design development during the technical development of new products, during their operation and repair; studying general issues of patenting and inventive activity strategies; studying the basic methods of design and activation of engineering creativity.	6						v			v	
46.	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	7									v	

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		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.											
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 specific conditions of the tasks performed and develop innovative solutions.	7					v			v		
48.	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.	8								v		
49.	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.	8								v	v	

## 5. Curriculum of educational program

### KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY NAMED AFTER K.I. SATBAYEV



**SATBAYEV  
UNIVERSITY**

**APPROVED**  
**Chairman of the Management Board-**  
**Rector of Kazntu named after K.Satpayev**  
\_\_\_\_\_ **M.M. Begentaev**  
« \_\_\_\_ » \_\_\_\_\_ **2022 y.**

### CURRICULUM

of Educational Program on enrollment for 2022-2023 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
<b>M-1. Module of language training</b>															
LNG 108	English 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						
<b>M-2. Module of physical training</b>															
KFK 101-104	Physical Culture	GED, RC	8	240	0/0/8	120	Difcredit	2	2	2	2				
<b>M-3. Module of information technology</b>															
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	☹		5						
<b>M-4. Module of socio-cultural development</b>															
HUM 100	Modern 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, politology)	GED, 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					
<b>M-5. Module of anti-corruption culture, ecology and life safety base</b>															
HUM 133	Fundamentals of anti-corruption culture	GED, CCH	5	150	2/0/1	150	E			5					
MNG 488	Fundamentals of Entrepreneurship and Leadership														
CHE 656	Ecology and life safety														
<b>M-6. Mathematical training module</b>															
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					
<b>M-7. Module of basic training</b>															

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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								
<b>M-8. Human Biology Module</b>																	
2201	elective	BD, EC	5	150		105	E			5							
2202	elective	BD, EC	5	150		105	E				5						
ROB531	Biofluids	PD, EC	5	150	2/1/0	105	E							5			
<b>M-9. Electronics and Circuit Engineering module</b>																	
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			
<b>M-10. Biomechanics Module</b>																	
3203	elective	BD, EC	5	150		105	E							5			
4302	elective	PD, EC	5	150		105	E									5	
<b>M-11. Programming module</b>																	
ROB504	Programming in a high level language	BD, UC	5	150	2/1/0	105	E							5			
ROB550	Programming for engineers with MATLAB	PD, UC	4	120	1/1/1	75	E									4	
<b>M-12. Measurement and processing module</b>																	
ROB187	Fundamentals of information and measurement technologies	BD, UC	5	150	2/1/0	105	E							5			
ROB568	Methods for processing and analyzing biomedical signals and data	PD, UC	6	180	1/1/2	120	E										6
<b>M-13. Biomedical Physics Module</b>																	
3204	elective	BD, EC	4	120		75	E									4	
ROB569	Thermodynamics of biological systems	PD, UC	4	120	1/1/1	75	E									4	
<b>M-14. Control module</b>																	
ROB514	Automation	BD, UC	5	150	2/0/1	105	E							5			
ROB311	Control in biotechnical systems	BD, UC	5	150	2/0/1	105	E									5	
3206	elective	BD, EC	6	180		120	E										6
<b>M-15. Module of biomedical systems</b>																	
4301	elective	PD, EC	5	150		105	E										5
4303	elective	PD, EC	6	180		120	E										6
<b>M-16. Biomedical Engineering Module</b>																	
ROB412	Biomedical engineering	BD, UC	5	150	2/0/1	105	E				5						
4305	elective	PD, EC	5	150		105	E										5
4306	elective	PD, EC	5	150		105	E										5
<b>M-17. R&amp;D Module</b>																	
ROB527	Fundamentals of research methodology	BD, UC	5	150	2/0/1	105	E							5			
3205	elective	BD, EC	5	150		105	E									5	
4304	elective	PD, EC	5	150		105	E									5	
4307	elective	PD, EC	5	150		105	E										5
<b>M-18. Practice module</b>																	
AAP179	Educational practice	BD, UC	2							2							
AAP174	Production practice I	PD, UC	2									2					
AAP193	Production practice II	PD, UC	3													3	
<b>M-19. Module of final attestation</b>																	
ECA003	Preparation and writing of a thesis (project)	FA	6														6
ECA103	Defense of the thesis (project)	FA	6														6

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M-20. Module of additional types of training														
AAP500	Military affairs	ATT	0											
							12	9	20	24	25	17	33	27
							21	44		42		60		

Total based on UNIVERSITY:

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**APPROVE**

**Director of the Institute of Automation and  
Information Technology**

\_\_\_\_\_ **Uskenbayeva R.K.**

«\_\_\_» \_\_\_\_\_ **2022 y.**

**Educational program 6B07114 - "Biomedical engineering"**

**Group of educational programs B063 - "Electrical engineering and automation"**

Form of study: full-time

Study period: 4 years

Academic degree: Bachelor of Engineering and Technology

Elective code according to the curriculum	Discipline code	Name of disciplines	Term	Cycle	Credits	Total hours	lek/lab/pr	SRS (including SRSP) in hours
<b>Human Biology Module</b>								
2201	ROB556	Human anatomy	3	BD UC	5	150	1/1/1	105
	ROB557	Anatomy with biomedical application					1/1/1	
2202	ROB501	Human biology	4	BD UC	5	150	2/0/1	105
	ROB558	Physiology with biomedical application					1/1/1	
<b>Biomechanics Module</b>								
3203	ROB507	Fundamentals of biomechanics	5	BD UC	5	150	2/0/1	105
	ROB559	Biomechanics Engineering					2/0/1	
4302	ROB560	Solid Biomechanics	7	PD UC	5	150	2/0/1	105
	ROB414	Orthopedic biomechanics					2/0/1	
<b>Biomedical Physics Module</b>								
3204	ROB561	Physics of the human body	6	BD UC	4	120	1/0/2	75
	ROB562	Biomedical physics					1/0/2	
<b>Control module</b>								
3206	ROB563	Mechanics of controlled machines	7	BD UC	6	180	1/1/2	120
	CSE576	Intelligent information and measurement systems					1/1/2	
<b>Module of biomedical systems</b>								
4301	ROB564	Fundamentals of medical optics	7	PD UC	5	150	1/1/1	105
	ROB140	Sensors in medicine					2/1/0	
4303	ROB565	Artificial life support equipment	7	PD UC	6	180	1/1/2	120
	ROB566	Biotechnical and medical diagnostic equipment					1/1/2	
<b>Biomedical Engineering Module</b>								
4305	ROB176	Clinical Engineering	8	PD UC	5	150	2/1/0	105
	ROB567	Cardiotechnics					1/1/1	
4306	ROB172	Medical imaging	8	PD UC	5	150	2/1/0	105
	ROB417	Inspection and testing of medical equipment					2/0/1	
<b>R&amp;D Module</b>								
3205	ROB141	Statistical methods in engineering research	6	PD UC	5	150	2/0/1	105
	ROB575	Fundamentals of engineering creativity					2/0/1	
4304	ROB415	Stereolithographic biomodeling in medicine	7	PD UC	5	150	2/0/1	105
	ROB540	Capstone research project I					0/0/3	

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4307	ROB135 ROB541	CAD of biotechnical and medical systems Capstone research project 2	8	PD UC	5	150	2/1/0 0/0/3	105
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The number of credits in elective subjects for the entire period of study	
Cycles of disciplines	Credits
Cycle of basic disciplines (B)	30
Cycle of profile disciplines (P)	36
<b>TOTAL:</b>	<b>66</b>

Number of credits for the entire study period					
Cycle code	Cycles of disciplines	Credits			
		Mandatory component (MK)	University component (UC)	Component of choice (CC)	Total
GED	Cycle of general education disciplines	51		5	56
BD	Cycle of basic disciplines		82	30	112
PD	Cycle of profile disciplines		24	36	60
	<b>Total for theoretical training:</b>	<b>51</b>	<b>106</b>	<b>71</b>	<b>228</b>
FA	Final attestation	12			12
	<b>IN TOTAL:</b>	<b>63</b>	<b>106</b>	<b>71</b>	<b>240</b>

**Remark:**

1. The names and amount of modules related to Module of basic training and professional activity are prescribed by departments themselves
2. \* - Division into types of work is at the department's discretion
3. If necessary, the disciplines: Physics II, Mathematics III, General Chemistry of the department include, at the expense of credits, the department's component of BD, UC from the basic training module
4. The full academic load of one academic year should be 60 academic credits
5. The application of elective disciplines catalog in the same way as Curriculum is divided into modules, with the inclusion of "R&D" module

Decision of the Academic Council of Kazntu named after K.Satpayev. Protocol № \_\_\_ or "\_\_\_" \_\_\_\_20\_\_ y.

Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № \_\_\_ or "\_\_\_" \_\_\_\_20\_\_ y.

Decision of the Academic Council of the Institute of A&IT. Protocol № \_\_\_ or "\_\_\_" \_\_\_\_20\_\_ y.

Vice-Rector for Academic Affairs

Director of the Institute of Automation and Information Technology

Head of the Department of Robotics and Automation Equipment

Specialty Council representative from employers

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\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

B.A. Zhautikov  
R.K. Uskenbayeva  
K.A. Ozhikenov  
A.K. Dzhumagulov



**6. Additional educational programs (Minor)**

<b>Name of additional educational programs (Minor) with disciplines</b>	<b>Total number of credits</b>	<b>Recommended semesters of study</b>	<b>Documents on the results of mastering the additional educational programs (Minor)</b>