



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

**EDUCATIONAL PROGRAM
7M07106- Biomedical Engineering**

Code and classification of the field of education:

7M07 Engineering, manufacturing and construction industries

Code and classification of training directions:

7M071 Engineering and engineering trades

Group of educational programs:

M102 Robotics and mechatronics

Level based on NQF: **7**

Level based on IQF: **7**

Study period: **2 year**

Amount of credits: **120**

Almaty 2023

Educational program 7M07106- Biomedical Engineering was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes #3 dated 27.10.2022

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

Minutes #2 dated 21.10.2022

Educational program 7M07106- Biomedical Engineering was developed by Academic committee based on direction 7M071 «Engineering and engineering trades»





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

EP - Educational program

BD - basic disciplines

PD - profile disciplines

ECTS - European Credit Transfer and Accumulation System

USEC - Universal, social and ethical competencies

S&MC - Special and managerial competencies

PC - Professional competence

EO - educational outcomes

FA - Final attestation

1. Description of educational program

Training of specialists in the field of medical and environmental equipment and technologies, the creation and maintenance of tools for diagnosis, treatment, rehabilitation and prevention of human diseases and development of software for solving problems of medical and biological practice.

Master's degree in the field of training "Biomedical Engineering" should be prepared to solve professional tasks in accordance with the profile of the master's program and the types of professional activities:

research activities:

- development of programs for scientific research and technical development, preparation of individual tasks for performers;

- collection, processing and systematization of scientific and technical information on the topic of planned research, selection of methods and tools for solving formulated tasks, preparation of tasks for performers;

- mathematical modeling of research technologies for biological objects and biotechnical systems for various purposes using standard software tools;

- development of physical, phenomenological, mathematical and information-structural models of biological objects and processes, assessment of their adequacy, determination of a set of independent indicators that characterize the studied biological object and process;

- organization and participation in conducting biomedical, environmental and ergonomic experiments, collection, processing, systematization and analysis of research results;

- preparation of scientific and technical reports in accordance with the requirements of regulatory documents, preparation of reviews and preparation of publications based on the results of conducted biomedical and environmental studies;

- analysis of patent materials and preparation of applications for inventions and industrial designs;

design and development activities:

- analysis of the state of scientific and technical problems by selecting, studying and analyzing literary and patent sources in the field of biotechnical systems and technologies;

- determination of the purpose, setting of design tasks, preparation of technical specifications for the performance of design works in the field of biotechnical systems and technologies;

- design of devices, devices, systems and complexes for biomedical and environmental purposes taking into account the specified requirements;

- development of design documentation in accordance with methodological and regulatory requirements.

organizational and managerial activities:

- development of organizational and technical documentation (work schedules, instructions, plans and estimates) and established reporting on approved forms;

- organization of work of small groups of performers involved in research, design and experimental research;

- control over the implementation of measures to prevent industrial injuries, occupational diseases, and prevent environmental violations in the process of research and operation of biological medical systems;

design and technological activities:

- development of technical specifications for the design of technological processes and production schemes for biomedical and environmental equipment using automated systems of technological pre-production;

- design of technological processes for the production of biomedical and environmental equipment using automated systems of technological pre-production;

- development of technological documentation for designed devices, devices, systems and complexes for biotechnical, medical and environmental purposes;

- ensuring the manufacturability of products and manufacturing processes, assessing the economic efficiency of manufacturing processes for biomedical and environmental equipment, as well as biotechnical systems in other areas;

- author's support of the developed devices, devices, systems and complexes at the design and production stages;

installation and commissioning activities:

- participation in verification, adjustment, adjustment, evaluation of equipment condition and configuration of biomedical systems for various purposes, including both technical means and software control systems;

- participation in interfacing software and hardware complexes with technical objects as part of biomedical systems, in conducting tests and commissioning prototypes of such systems;

service and maintenance activities:

- participation in verification, adjustment, adjustment and assessment of the state of biomedical systems for various purposes, as well as their individual subsystems, in the setting up of control hardware and software complexes;

- preventive control of technical condition and functional diagnostics of biomedical systems for various purposes, as well as their individual subsystems;

- preparation of operating instructions for biomedical systems and their hardware and software, development of routine testing programs;

preparation of applications for equipment and components, preparation of technical documentation for equipment repair;

The objects of professional activity of the graduate are:

- biomedical engineering, including information-sensory, Executive and control modules, their mathematical, algorithmic and software, methods and means of their design, modeling, experimental research and design;

- theoretical and experimental studies, analysis of signals, analytical relation for the optimum processing of multidimensional signals, mathematical foundations of pattern recognition, processing, identification and synthesis of speech signals, problem-oriented software systems in biomedical practice, the kinds of provisions for biomedical research, principle that structures the problem-oriented system, message processing of diagnostic information in real time, complex for

the collection, analysis, processing and storage of biomedical information; data and knowledge bases, systems of forecasting and decision-making software systems, health-technical support of medical institutions.

The term of study in the master's program is determined by the volume of academic credits mastered. When the established amount of academic credits is mastered and the expected learning outcomes for obtaining a master's degree are achieved, the master's degree program is considered fully mastered. In the scientific and pedagogical master's program, at least 120 academic credits are awarded for the entire period of study, including all types of educational and scientific activities of the master's student.

Planning of the content of education, the way of organizing and conducting the educational process is carried out by the University and scientific organization independently on the basis of credit technology of training.

The master's program in scientific and pedagogical direction implements educational programs of postgraduate education for the training of scientific and scientific and pedagogical personnel for Universities and scientific organizations with in-depth scientific and pedagogical and research training.

The content of the master's degree EP consists of:

- 1) theoretical training, including the study of cycles of basic and profile disciplines;
- 2) practical training of undergraduates: various types of internships, scientific or professional internships;
- 3) research work, including the execution of a master's thesis – - for the scientific and pedagogical master's program
- 4) final certification.

Final certification is carried out in the form of writing and defending a master's thesis.

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 robotics and mechatronics in the labor market, capable of performing design, production, technical, organizational work in professional activities

Tasks of EP:

- development of students through research activities, critical thinking, development of professionally oriented skills and abilities;
- using highly professional experience of teaching undergraduates in various educational environments;
- training a new competitive generation of technical specialists for the labor market;
- developing an environment that welcomes and supports people from different cultures, and creating an atmosphere of striving for knowledge, academic integration and intellectual motivation;
- conducting research, conducting educational activities based on world best practices, and developing their own brand of training specialists;
- development of cooperation "University-industry" to meet the requirements of the labor market for technical specialists, to improve the quality of educational programs for training specialists for the economy and business sector;
- development of additional educational and training programs using multimedia, new teaching technologies for organizing learning based on the principle of lifelong learning;
- establishing partnerships with other universities and organizations to improve the quality of education, to support technical and cultural ties.

Competencies for completing training

Universal, social and ethical competencies (USEC)	
U-1	Ability to communicate orally and in writing in the state, Russian and foreign languages to solve problems of interpersonal and intercultural interaction
U-2	The ability to assess the surrounding reality based on worldview positions formed by knowledge of the basics of philosophy, which provide scientific understanding and study of the natural and social world by methods of scientific and philosophical knowledge
U-3	Develop an environment that welcomes and supports people from different cultures, and create an atmosphere of striving for knowledge, academic integration, and intellectual motivation
U-4	Have the skills of social design and methods of forming and maintaining the socio-psychological climate in the organization
U-5	Ability to critically use the methods of modern science in practice
U-6	Awareness of the need and ability to learn and improve their skills independently throughout their working life
Special and managerial competencies (S&MC)	
S-1	Independently manage and control the processes of work and training activities within the framework of the strategy, policy and goals of the organization, discuss problems, argue conclusions and correctly operate with information

S-2	Organize the activities of the production team, make organizational and managerial decisions in the context of different opinions and evaluate the consequences of decisions
S-3	Organize work in the division to improve, modernize, and unify manufactured biomedical products
S-4	Readiness to lead and participate in the preparation of a feasibility study for projects to create biomedical systems, their subsystems and individual modules
S-5	Ability to critically analyze, present, defend, discuss and disseminate the results of their professional activities
Professional competencies (PC)	
PC-1	Ability to analyze literature data and, based on the analysis, be able to identify and experimentally implement possible ways to improve biomedical systems
PC-2	Ability to conduct professional written and oral communication with all stakeholders in the field of biomedical engineering
PC-3	The ability to demonstrate a sustained interest in self-study and training of both wards and colleagues, to guide and advise them throughout the entire period of professional activity
PC-4	Ability to demonstrate a high level of professional activity while solving industrial and / or scientific tasks, observing all the principles of legal and ethical standards
PC-5	Ability to conduct independent research in biomedical engineering and modernize existing biomedical systems, introduce new methods of digital signal processing with elements of artificial intelligence
PC-6	Ability to design modern and reliable blocks and devices, intelligently controlled Executive, information-sensor and navigation modules of biomedical devices and devices
PC-7	Ability to apply modern software products and the latest technologies to solve and manage interdisciplinary engineering problems in various fields of science and technology
PC-8	The ability to create adaptive and robust control systems of biotechnical objects
PC-9	Ability to implement scientific results in the production of biomedical products

3. Requirements for evaluating the educational program learning outcomes

EO1 - Demonstrate professional written and oral communication skills, as well as critical thinking and interdisciplinary problem solving skills.

EO2 – Demonstrate a steady interest in self-learning and learning of both mentees and colleagues, guide and advise them throughout the entire period of professional activity.

EO3 – Formulate innovative tasks in the field of biomedical engineering and apply project management methods for their implementation, evaluate the quality of the project management system, analyze the effectiveness of business processes, use software products to perform project management tasks.

EO4 – Design modern and reliable blocks and devices, intelligently controlled executive, information-sensor and navigation modules of biomedical devices and devices and carry out comprehensive research, including interdisciplinary, based on a holistic systematic scientific worldview using knowledge in the field of history and philosophy of science.

EO5 – Apply modern technical means, software products for information management and processing, and the latest technologies to solve problems in the field of biomedical engineering.

EO6 – Organize the activities of the team, make organizational and managerial decisions in the context of different opinions and assess the consequences of the decisions taken.

EO7 – Apply methods and techniques of managing a medical-technical enterprise, organize and carry out work on the purchase and equipping of medical and preventive institutions with modern medical equipment, their operation, installation and commissioning. Develop a marketing package.

4. Passport of educational program

4.1. General information

№	Field name	Comments
1	Code and classification of the field of education	7M07 Manufacturing and processing industries
2	Code and classification of training directions	7M071 Engineering and engineering trades
3	Educational program group	M102 Robotics and mechatronics
4	Educational program name	7M07106 Biomedical Engineering
5	Short description of educational program	Training of specialists in the field of medical and environmental equipment and technologies, the creation and maintenance of tools for diagnosis, treatment, rehabilitation and prevention of human diseases and development of software for solving problems of medical and biological 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 scientific, pedagogical, industrial, technical and organizational work in professional activities.
7	Type of EP	New
8	The level based on NQF	7
9	The level based on IQF	7
10	Distinctive features of EP	-
11	List of competencies of educational program	In the field of research methodology; in the field of scientific and scientific-pedagogical activity in higher educational institutions; in matters of modern educational technologies; in the implementation of scientific projects and research in the professional field; in the field of information analysis.
12	Learning outcomes of educational program	EO1-EO07
13	Education form	full-time
14	Period of training	2 year
15	Amount of credits	120
16	Languages of instruction	russian, kazakh
17	Academic degree awarded	Master of Technical Sciences/Master of Engineering and Technology in the educational program « 7M07106 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
Cycle of basic disciplines										
University component										
1.	Foreign language (professional)	The course is designed for undergraduates of technical specialties to improve and develop foreign language communication skills in professional and academic fields. The course introduces students to the general principles of professional and academic intercultural oral and written communication using modern pedagogical technologies.	5	v						
2.	Psychology of management	The discipline studies the modern role and content of psychological aspects in managerial activity. The improvement of the psychological literacy of the student in the process of implementing professional activities is considered. Self-improvement in the field of psychology and studying the composition and structure of management activities, both at the local level and abroad. The psychological feature of modern managers is considered.	3				v		v	v
3.	History and philosophy of science	The subject of philosophy of science, dynamics of science, specifics of science, science and pre-science, antiquity and the formation of theoretical science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy of mathematics, physics, engineering and technology, specifics of engineering sciences, ethics of science, social and moral responsibility of a scientist and engineer.	3				v			
4.	Higher school pedagogy	Undergraduates will master the methodological and theoretical foundations of higher school pedagogy, plan and organize the processes of teaching and upbringing, master the communicative technologies of subject-subject interaction between a teacher and a master in the educational process of a university.	3		v					
Cycle of basic disciplines										
Component of choice										
5.	Biotechnical systems and technologies	The purpose of studying the discipline is to study methods and techniques of analysis and creation of biotechnical systems and technologies. The processes of interaction of biological and technical systems are considered in detail. To show the possibility of applying biotechnical systems and technologies in various fields of biology and medicine. The features of displaying information about the state of the body and the parameters of impacts in the composition of biotechnical systems, the	5				v	v		

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		main modern trends in the development of biotechnical technologies are studied.									
6.	Intelligent information management and processing systems	The discipline is aimed at studying the theoretical foundations and practical mastering of working with neural networks, genetic algorithms and expert systems. Formation of practical skills in the use of intelligent systems for management. Understanding the place of intelligent methods among all information technologies. The concept of basic intelligent technologies, their use in computer control systems and application for solving applied problems.	5					✓	✓		
7.	Application of methods of technical creativity in innovative activities	The purpose of studying the discipline is to master the basics of practical application of methods of technical creativity in innovation. The basic knowledge and skills of applying the methods of technical creativity in innovation are offered. After studying the course, a master's student must demonstrate the ability to analyze, synthesize and design methods of technical creativity in innovation, as well as assess their significance for biotechnology, biomedicine and medicine.	5					✓	✓		
8.	Theory of Inventive Problem Solving in Instrument Making	The purpose of studying the discipline is to master the theoretical foundations of solving inventive tasks. Basic knowledge in the field of solving inventive tasks, as well as skills in working with normative documents of invention will be presented. After studying the course, a master's student must demonstrate the ability to analyze, synthesize and design solutions to inventive tasks, as well as assess their significance for society, biotechnology, biomedicine and medicine.	5					✓	✓		
9.	Mathematical modeling of biological processes and systems	The purpose of studying the discipline is to form a system of views among undergraduates on the correct use of existing mathematical methods and algorithms for analyzing experimental information of various physical nature; to teach them to independently use the available mathematical apparatus for evaluating measurement results, the optimal choice of theoretical and technical means for evaluating measurement results. Studies mathematical regularities of biophysical processes and systems.	5					✓	✓		
10.	Modern methods of processing biomedical signals and images	The purpose of studying the discipline is to form and deepen knowledge about the methods of processing biomedical signals and data. Formation of knowledge about signal processing methods of electrocardiography, high-resolution electrocardiography, rheography, sphygmography, phonocardiography, electroencephalography, electromyography. Formation of knowledge of practical use and implementation of theoretical foundations of automated biomedical systems	5					✓	✓		
Cycle of profile disciplines University component											
11.	Computer technologies in	The purpose of studying the discipline is to form the necessary	5					✓	✓		

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	biomedical research	knowledge about technical and software tools for biomedical research, about the creation of algorithms for processing biosignals, ideas about methods and technologies for processing physical information received from a biological object, about computer systems as a tool for working with information, about methods for automating the creation and maintenance of software.								
Cycle of profile disciplines Component of choice										
12.	Control in biotechnical and medical systems	The discipline studies the theories and methods of automatic and automated control used in the creation of biotechnical systems for various purposes and automated health management systems. Forms knowledge, skills, skills and competencies on control systems of biotechnical systems; beliefs about the need for the development of automatic biotechnical systems to ensure human life; the use of information tools necessary for future professional activity.	5				v	v		
13.	Intellectual management in conditions of uncertainty	The discipline "Intellectual management in conditions of uncertainty" is aimed at studying the problems of managing continuous dynamic objects under uncertainty. The tools of sensitivity theory, interval model representations, generalized modal control, Lyapunov function method and adaptive control are studied. Designing control laws that deliver robustness to systems in the sense of the main indicators of the quality of their functioning. Non-adaptive and adaptive management methods.	5	v			v	v		
14.	Biomedical measuring information systems	The purpose of studying the discipline is to gain new knowledge through the development of fundamental and applied scientific research in the field of biomedical engineering; preparation for research activities, the objects of which are devices, systems and complexes of biomedical purposes, methods and technologies for performing medical, biological, environmental research; automated systems for processing biomedical information; biotechnical control systems.	5				v	v		
15.	Technical means of information-measuring systems	The purpose of studying the discipline is the formation of students' knowledge in the field of information and measurement systems: components, algorithms, structures, characteristics, varieties and purposes of modern information and measurement systems and their parts; features of the use of computers and computer technology in information and measurement systems; organization of human interaction and technology in information and measurement systems; metrological providing systems; sources, types and performance indicators of information and measurement systems	5					v		v
16.	Diagnostics and reliability of technical systems and devices	The purpose of studying the discipline is to study methods for assessing the reliability of technical systems at the design stage, to study methods for assessing the reliability of technical systems in operation, to apply	5				v			v

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		probability theory to predict and prevent equipment failures, to study methods for diagnosing existing equipment. Accordingly, the teaching of the discipline "Diagnostics and reliability of technical systems and devices" is aimed at arming future specialists with knowledge of the basic provisions of the theory of reliability and survivability of technical systems.								
17.	Verification, safety and reliability of medical equipment	The purpose of studying the discipline is the formation of knowledge about the operation and maintenance of medical devices, biotechnical systems and devices in the conditions of biomedical organizations, training in the principles of ensuring safe living conditions in the development, production and operation of biomedical devices, complexes and systems, training in how to apply methods of organizing routine maintenance, verification and certification of medical equipment.	5					✓		✓
18.	Detection and filtering of biomedical signals	The purpose of the discipline is to study methods and algorithms for processing biomedical signals and data used in the creation of biotechnical and medical systems. Studying the discipline gives undergraduates the basics of engineering and theoretical skills in processing and analyzing biomedical information. The use of computer technologies for filtering and eliminating artifacts, for identifying discrete epochs of a biomedical signal, for classifying images and making diagnostic decisions.	5					✓	✓	
19.	Fundamentals of marketing and management in medical and technical enterprises	The purpose of studying the discipline is the formation of knowledge in the field of operation and maintenance of the latest medical equipment and the specifics of medical devices as a special type of industrial goods, as well as the acquisition of practical teamwork skills, problem analysis and the development of management solutions. Study of the basic concepts and categories, as well as trends in the development of management and marketing at medical and technical enterprises	5							✓
20.	Medical information systems	The purpose of studying the discipline is to get acquainted with the principles, methods and means of building medical information systems, medical information resources. The study of ways and means of interaction of medical information systems using modern computer technology and new information technologies. Acquisition of skills in designing, developing, implementing and operating medical information systems in medical institutions of various profiles	5					✓	✓	
21.	Automated design of medical equipment	The purpose of studying the discipline is to study the methodology of modern methods of designing medical equipment. After studying, the master's student systematizes, consolidates and deepens the theoretical knowledge and skills acquired, applies this knowledge at the stage of technical design, developing skills for independent work, conducting theoretical and experimental research with the involvement of means and	5					✓	✓	

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		methods of microprocessor technology.									
22.	Designing microprocessor and microcontroller systems	The discipline is aimed at forming students' knowledge of the general methodology and specific design methods of the main varieties of modern microprocessor tools, as well as knowledge and skills in the field of architecture, principles of functioning and programming of microprocessor systems. Studies the architecture and functionality of modern microprocessors and microcontrollers; methods and technical means of debugging, diagnostics, modeling and design of microprocessor systems and microcontrollers	5					✓	✓		
23.	Quality management of production and service of medical equipment	The purpose of studying the discipline is to study the quality assessment model of the process of repair and maintenance of medical equipment. To identify the signs of quality assessment at enterprises for the repair and maintenance of medical equipment. The study of the quality management system of processes in the industrial, commercial and educational spheres. The product quality management system is a set of management bodies and management facilities, measures, methods and means aimed at establishing, ensuring and maintaining a high level of product quality.	5							✓	✓
24.	Organization and planning of the production of medical equipment	The purpose of studying the discipline is to study in the interrelation of the most important issues and factors of the science of the organization of the production of medical equipment, ensuring the effective functioning of an industrial enterprise – the primary link of the material production of medical equipment. The principles of the organization of production processes of medical equipment are studied. Indicators of the organization of the production process. The concept of the organizational type of production and its defining features of medical equipment. Organization of research and development work. Planning of technical training	5					✓		✓	✓
25.	Artificial intelligence in medicine	The purpose of studying the discipline is to study the essence and principles of biomedical information processing. Intelligent signal processing methods in biomedicine. Using fuzzy logic theory, wavelet analysis, fractal theory, expert approach and artificial neural network theory to solve biomedical signal processing problems. Definition and classification of biomedical images. Development and operation of medical information systems. Modern methods of processing biomedical images.	5					✓	✓		
26.	Intelligent control technology	Studying the theoretical foundations of artificial intelligence, neural network technologies of intelligent systems, technologies for constructing control systems with fuzzy logic, rules of fuzzy logic, technologies for creating a knowledge base, expert control systems, adaptive control systems, theoretical problems and techniques of intelligent systems, etc. These knowledge are necessary for further understanding of the principles of construction of robotic systems	5					✓	✓		

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27.	Project Management	The discipline studies the components of project management based on modern behavioral models of project-oriented business development management. The program is based on the international standards PMI PMBOK, IPMA ICB and the standards of the Republic of Kazakhstan in the field of project management. The features of organizational management of business development through the interaction of strategic, project and operational management are studied.	5			v			v	
28.	Digital processing of measurement information	The purpose of the discipline is to study the role and significance of digital signal processing in the reception and transmission of information, the features and advantages of digital representation of signals, the study of digital transformation algorithms, the implementation of digital processing in telecommunications, information-measuring and radiophysical systems and its application in various fields of science, technology and production.								

5. Curriculum of educational program

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APPROVED



Chairman of the Management Board-
Rector of Kazntu named after K.Satpayev
_____ M.M. Begentaev
«___» _____ 2023 y.

CURRICULUM
of Educational Program on enrollment for 2023-2024 academic year
Educational program 7M07106 - "Biomedical engineering"
Group of educational programs M102 - "Robotics and mechatronics"

Form of study: full-time		Duration of study: 2 year			Academic degree: Master of Technical Sciences						
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			
								1 course		2 course	
								1 semester	2 semester	3 semester	4 semester
M-1. Module of basic training (university component)											
LNG210	English (professional)	BD UC	5	150	0/0/3	105	E	5			
HUM214	Management Psychology	BD UC	3	90	1/0/1	60	E		3		
HUM212	History and philosophy of science	BD UC	3	90	1/0/1	60	E		3		
HUM213	Higher school pedagogy	BD UC	3	90	1/0/1	60	E	3			
optional component											
ROB266	Biotechnical systems and technologies	BD CCH	5	150	2/0/1	105	E	5			
ROB204	Intelligent information management and processing systems	BD CCH			2/1/0						
ROB262	Application of methods of technical creativity in innovation	BD CCH	5	150	2/0/1	105	E	5			
ROB263	Theory of inventive problem solving	BD CCH									
ROB276	Mathematical modeling of biological processes and systems	BD OU	5	150	2/0/1	105	E		5		
ROB219	Modern methods of processing biomedical signals and images	BD OU									
M-2.Module of theoretical foundations of management											
ROB267	Computer technologies in biomedical research	PD UC	5	150	2/0/1	105	E	5			
ROB258	Management in biotechnical and medical systems	PD OC	5	150	2/0/1	105	E		5		
ROB203	Intelligent management in conditions of uncertainty										
ROB261	Biomedical measurement information systems	PD OC	5	150	2/0/1	105	E			5	

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ROB224	Technical means of information and measuring systems											
MNG705	Project management											
M-3. Control Design Module (optional component)												
ROB277	Diagnostics and reliability of technical systems and devices	PD OC	5	150	2/0/1	105	E	5				
ROB278	Verification, safety and reliability of medical equipment											
ROB244	Detection and filtering of biomedical signals	PD OC	5	150	2/0/1	105	E		5			
ROB279	Digital processing of measurement information											
ROB271	Fundamentals of marketing and management at medical and technical enterprises	PD OC	5	150	2/0/1	105	E			5		
ROB287	Medical information systems	PD OC	5	150	2/0/1	105	E			5		
ROB282	Computer-aided design of medical equipment				2/0/1							
ROB239	Design of microprocessor and microcontroller systems	PD OC	5	150	2/1/0	105	E			5		
ROB246	Quality management of production and service of medical equipment	PD OC	5	150	2/0/1	105	E			5		
ROB247	Organization and planning of medical equipment production											
ROB268	Artificial intelligence in medicine	PD OC	5	150	2/0/1	105	E			5		
ROB225	Intelligent control technology											
M-4. Practice-oriented module												
AAP229	Pedagogical practice	BD UC	6						6			
AAP269	Research practice	PD, CCH	8								8	
M-5. Experimental research module												
AAP251	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	2					2				
AAP241	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	3						3			
AAP254	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	5							5		
AAP255	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	14								14	
M-6. Module of final attestation												
ECA212	Preparation and defense of a master's thesis	FA	8								8	
Total based on UNIVERSITY:								30	30	30	30	
								60	60			

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

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
			university component (UC)	component of choice (CCH)	Total
BD	Cycle of basic disciplines		20	15	35
PD	Cycle of profile disciplines				53
	<i>Total for theoretical training:</i>	<i>0</i>	<i>20</i>	<i>15</i>	<i>88</i>
	RWMS				<i>24</i>
FA	Final attestation	8			8
	TOTAL:	8	20	15	120

Decision of the Academic Council of Kazntu named after K.Satpayev. Protocol № 3 27.10.2022 y.

Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № 2 21. 10. 2022 y.

Decision of the Academic Council of the Institute Automation and Information Technology. Protocol № __от " __ " ____20__ y.

Vice-Rector for Academic Affairs

B.A. Zhautikov

Director of the Institute of Automation and
Information Technology

R.K. Uskenbayeva

Head of the Department of Robotics and Automation
Equipment

K.A. Ozhikenov

Specialty Council representative from employers

A.K. Dzhumagulov

6. Additional educational programs (Minor)

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