Institute of Automation and Information Technology
Department "Robotics and Engineering Tools of Automation"

EDUCATIONAL PROGRAM
8D07105 Biomedical engineering

Code and classification of the field of education:
8D07 Engineering, manufacturing and construction industries
Code and classification of training directions:
8D071 Engineering and engineering trades
Group of educational programs:
D102 Robotics and mechatronics
Level based on NQF: **8**
Level based on IQF: **8**
Study period: **3 year**
Amount of credits: **180**

Almaty 2024

Educational program 8D07105 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 8D07105 Biomedical engineering was developed by Academic committee based on direction 8D071 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 Kuyzembaevich	-	General Director	LLP «MEDREMZAVOD HOLDING»	
Akzhanov Janat Koishubaevich	-	Director	LLP «SAIMAN Corporation»	
Students				
Temirzhanov Alisher Alibekuly	-	1st year Doctoral 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
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 highly qualified specialists who are able to conduct research on innovative areas of biomedical engineering development that meets international standards and allows Kazakhstan to integrate into the global educational space. Graduates are awarded PhD degree.

A doctoral student in the direction of training "Biomedical Engineering" should be prepared to solve professional problems in accordance with the profile direction of the doctoral program and types of professional activities:

design and engineering activities:

- analysis of the state of a scientific and technical problem and the definition of goals and objectives for the design of biomedical systems based on the study of world experience;
- making decisions based on the results of calculations for projects and the results of a technical, economic and functional cost analysis of the effectiveness of the designed biomedical systems;

production and technological activities:

- development of methods for conducting theoretical and experimental research on the analysis, synthesis and optimization of the characteristics of materials used in the field of biomedical engineering;
- solving economic and organizational problems of technological preparation of production of biomedical systems and the choice of systems for ensuring the environmental safety of production;

scientific and research activities:

- construction of mathematical models for the analysis and optimization of research objects, the choice of a numerical method for their modeling or the development of a new algorithm for solving the problem;
- development and optimization of field experimental studies of biomedical systems, taking into account the criteria of their reliability;
- preparation of scientific and technical reports, reviews, publications based on the results of research performed;
- application of the results of research activities and the use of rights to objects of intellectual property;

organizational and management activities:

- finding optimal solutions when creating science-intensive products, taking into account the requirements of quality, cost, deadlines, competitiveness, life safety, as well as environmental safety;
- support of a unified information space for planning and enterprise management at all stages of the life cycle of manufactured products;
- development of plans and programs for organizing innovative activities at the enterprise;
- deep knowledge and understanding of fundamental phenomena in their field of science.

scientific and pedagogical activity:

- development of programs of academic disciplines and courses based on the study of pedagogical, scientific, technical and scientific-methodical literature, as well as the results of their own professional activities;

- setting up and modernization of individual laboratory works and workshops in professional disciplines;

- conducting training sessions with students, participating in the organization and management of their practical and research work;

- application and development of new educational technologies, including computer and distance learning systems.

Objects of professional activity:

- teaching activity in higher educational institutions according to the profile of training;

- research activities in higher educational institutions and scientific organizations according to the profile of training;

- professional activity in the field of biomedical engineering, requiring highly qualified personnel;

- administrative and organizational activities in higher educational institutions and scientific organizations by training profile.

The main criterion for the completeness of the educational process for the preparation of doctors of philosophy (PhD) (doctor in the profile) is the mastering of at least 180 academic credits by a doctoral student, including all types of educational and scientific activities.

The term of study in doctoral studies is determined by the amount of acquired academic credits. Upon mastering the established amount of academic credits and achieving the expected learning outcomes for obtaining a PhD degree or by profile, the doctoral educational program is considered fully mastered and completed with the successful defense of a doctoral dissertation prepared in compliance with the existing rules.

Training of personnel in doctoral studies is carried out on the basis of educational programs in two directions:

1) scientific and pedagogical with a training period of at least three years;

2) specialized with a training period of at least three years.

Final certification is carried out in the form of writing and defending a doctoral dissertation

2. Purpose and objectives of educational program

Purpose of EP: The purpose of the educational program is to provide comprehensive and high-quality training of highly qualified specialists in the field of biomedical engineering, ready to solve scientific, practical and theoretical tasks of professional activity in modern conditions.

Tasks of EP:

- the direction of its activities to make a contribution to the development of a knowledge-based society by providing educational programs in the system of continuing education;
- development of students through research activities, critical thinking, development of professionally oriented skills and abilities;
- the use of highly professional experience in teaching doctoral students in a variety of 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 pursuit of knowledge, academic integration and intellectual motivation;
- carrying out research work, conducting educational activities based on the best world practice, and developing its own school for training specialists;
- development of cooperation "university-industry" to meet the labor market requirements for technical specialists, to improve the quality of educational programs for training specialists for the national industry and the economy and business sector;
- development of additional educational and training programs using multimedia and new teaching technologies for organizing learning based on the principle of lifelong learning;
- establishing partnerships with other universities, organizations in order to improve the quality of education, to support technical and cultural ties.

Competencies at the end of training

Universal, social and ethical competencies (USEC)	
U-1	Have an idea of the pedagogical and scientific ethics of a research scientist
U-2	Have an understanding of the norms of interaction in the scientific community
U-3	to Know and understand the methodology of scientific knowledge
U-4	Ability to critically use the methods of modern science in practical activities
U-5	ggenerate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge
Special and managerial competencies (S&MC)	
S-1	Independently manage and control the processes of labor and educational activities within the framework of the strategy, policy and goals of the organization, discuss problems, argue conclusions and competently 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	ToTo conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis
S-4	Readiness to lead and participate in the preparation of technical and economicfeasibility studies for the creation of biotechnical systems, their subsystems and individual modules
S-5	Ability to critically analyze, present, protect, discuss and disseminate the results of their professional activities
Professional competencies (PC)	
PC-1	Analyze the state of scientific and technical problems and determine the goals and objectives of designing biotechnical systems based on the study of world experience
PC-2	Decision-making based on project calculations and results of technical-economic and functional-cost analysis of the effectiveness of designed biotechnical systems
PC-3	Develop a methodology for conducting theoretical and experimental studies on the analysis, synthesis and optimization of the characteristics of materials used in the field of biomedical engineering
PC-4	Build mathematical models for analyzing and optimizing research objects, choose a numerical method for modeling them, or develop a new algorithm for solving
PC-5	Find optimal solutions for creating high-tech products, taking into account the requirements of quality, cost, deadlines, competitiveability , life safety, and environmental safety
PC-6	Develop curricula of academic disciplines and courses based on the study of pedagogical, scientific, technical and scientific-professional activities in the field of biomedical engineering

3. Requirements for evaluating the educational program learning outcomes

EO1 - Demonstrate a high level of professional activity while solving industrial and / or scientific problems, observing all the principles of legal and ethical standards.

EO2 – Design individual blocks and devices of biomedical systems, intelligently controlling, information-sensory and executive subsystems and modules, in accordance with the terms of reference.

EO3 – Explore in the development of new samples and improvement of existing biomedical systems, the search for new ways of managing and processing information.

EO4 – Planning tests of modules and subsystems of biomedical systems, organizing and conducting experiments on operating objects and experimental models, processing the results of experimental studies using modern information technologies.

EO5 – Find the best solutions when creating science-intensive products, taking into account the requirements of quality, cost, deadlines, competitiveness, life safety, and environmental safety.

EO6 – Analyze literature data and, based on the analysis, be able to identify and experimentally implement possible ways to improve the quality of biomedical systems.

4. Passport of educational program

4.1. General information

№	Field name	Comments
1	Code and classification of the field of education	8D07 Manufacturing and processing industries
2	Code and classification of training directions	8D071 Engineering and engineering trades
3	Educational program group	D102 Robotics and mechatronics
4	Educational program name	8D07105 Biomedical engineering
5	Short description of educational program	Training of highly qualified specialists who are able to conduct research on innovative areas of biomedical engineering development that meets international standards and allows Kazakhstan to integrate into the global educational space. Graduates are awarded PhD degree.
6	Purpose of EP	The purpose of the educational program is to provide comprehensive and high-quality training of highly qualified specialists in the field of biomedical engineering, ready to solve scientific, practical and theoretical tasks of professional activity in modern conditions.
7	Type of EP	New
8	The level based on NQF	8
9	The level based on IQF	8
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 use of modern methods and technology of scientific communication in the state of foreign languages; in the field of planning and solving the problem of their own professional and personal development.
12	Learning outcomes of educational program	EO1-EO06
13	Education form	full-time
14	Period of training	3 year
15	Amount of credits	180
16	Languages of instruction	russian, kazakh
17	Academic degree awarded	Doctor of Philosophy PhD/ according to the educational program «8D07105 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
Cycle of basic disciplines University component									
1.	Scientific research methods	The training course allows you to gain knowledge on the basic theoretical provisions, technologies, operations, practical methods and techniques for conducting scientific research based on modern achievements of domestic and foreign scientists and master the skills of choosing a topic for scientific research, scientific research, analysis, experimentation, data processing, obtaining reasonable effective solutions using information technology.	5			v	v	v	
2.	Academic writing	Purpose: to develop academic writing skills and writing strategies among doctoral students in the fields of engineering and natural sciences. Contents: fundamentals and general principles of academic writing, including: writing effective sentences and paragraphs, writing an abstract, introduction, conclusion, discussion, conclusion, references used; in-text citation; preventing plagiarism, as well as preparing a presentation at a conference.	5	v					v
3.	Pedagogical practice	The goal is for doctoral students to master the technology of higher education in the Republic of Kazakhstan, the economics of the educational system, the organization of education and its management. Within the framework of pedagogical practice, the following will be studied: the possession of teachers' best practices in the relevant field of science and the use of regulatory documents on the educational program.	10						
Cycle of basic disciplines Component of choice									
4.	Automated systems for processing biomedical information	The discipline is aimed at forming ideas about the correct application of existing mathematical methods and algorithms for the analysis of experimental information of various physical nature in biomedical practice. Biological signals and their properties. Analytical connections	5	v					v

		of optimal processing of multidimensional signals. Mathematical foundations of pattern recognition. Problem-oriented software systems in biomedical practice. Software for processing diagnostic information in real time.							
5.	Modern technologies of bioelectric control of systems	The purpose of the discipline is based on the use of bioelectric potentials of a living organism as control actions. Contents: theoretical and experimental aspects of the problem of bioelectric control are the basis for the creation of bioelectric control systems. Biological control systems are a specialized type of automated control system and, similar to the reflex arc, systems include a sensor (analog of a receptor), a logic element (analog of a ganglion) and an executive element (analog of a muscle or gland).	5					v	
6.	Intellectual Property and the global market	Purpose: the goal is to train specialists in the field of intellectual property law who can analyze and predict trends in its development in the global market, develop strategies for the protection and commercialization of intellectual property. Contents: global aspects of intellectual property and its role in international trade and economics, analysis of international agreements and conventions, IP management strategies, cases of protection and violation of intellectual property rights in various jurisdictions.	5	v					
Cycle of profile disciplines University component									
7.	Research practice	The main purpose of the doctoral student's research practice is to study the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as to consolidate practical skills in applying modern research methods, processing and interpreting experimental data in dissertation research.	10						
Cycle of profile disciplines Component of choice									
8.	Biomedical intelligent systems	The discipline is aimed at preparing doctoral students to participate in the design of devices, devices, systems and complexes, using modern intelligent technologies for processing and analyzing signals and data. The course examines the principles of formation of doctoral students'	5		v	v			

		knowledge in the field of modern ideas about biomedical intelligent systems.							
9.	Intelligent machine vision systems	The purpose of the discipline is aimed at the formation of a complex of knowledge, skills and abilities in the field of application of modern methods of image processing and analysis and the construction of software complexes and systems for intelligent processing of digital graphics. Contents: mastering the main directions of development of applied research in the field of digital image processing; studying methods for searching for special points in images; studying the main image processing software libraries; mastering methods for solving practical problems of digital image processing.	5		**v**	**v**			
10.	Design of technical means for collecting, processing and analyzing biomedical signals	The discipline is aimed at acquainting students with current problems and promising areas in the design of technical means for the removal, processing and analysis of biomedical signals using modern methods of computer-aided design - CAD, acquiring practical skills in solving modern design problems.	5		**v**	**v**			
11.	Methods of mathematical processing of biomedical data	The purpose of the course is to form doctoral students' systems of views on the correct use of existing mathematical methods and algorithms for analyzing experimental information of various physical nature. Formation of a general idea of the content, tasks and methods of scientifically based assessments of measurement results in the field of biomedical research.	5				**v**		**v**

KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I.SATPAYEV

SATBAYEV UNIVERSITY

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

CURRICULUM

of Educational Program on enrollment for 2024-2025 academic year
Educational program 8D07105 - "Biomedical engineering"
Group of educational programs 8D102 - "Robotics and mechatronics"

Form of study: full-time Duration of study: 3 year Academic degree: PhD

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 terms and semesters					
								1 course		2 course		3 course	
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester
M-1. Module of basic training (university component)													
CSE339	Scientific research methods	BD UC	5	150	2/0/1	105	E	5					
LNG305	Academic writing	BD UC	5	150	0/0/3	105	E	5					
M-2. Control systems module (optional component)													
ROB318	Automated systems for processing biomedical information	BD CCH	5	150	2/0/1	105	Э	5					
ROB328	Modern technologies of bioelectric control of systems												
MNG349	Intellectual Property and the global market												
M-3. Intelligent systems module (optional component)													
ROB324	Biomedical intelligent systems	PD, CCH	5	150	2/0/1	105	Э	5					
ROB329	Intelligent machine vision systems												
M-4. Engineering module (optional component)													
ROB325	Design of technical means for collecting, processing and analyzing biomedical signals	PD, CCH	5	150	2/0/1	105	Э	5					
ROB314	Methods of mathematical processing of biomedical data												
M-5. Practice-oriented module													
AAP350	Pedagogical practice	BD UC	10						10				
AAP355	Research practice	PD UC	10							10			
M-6. Experimental research module													
AAP336	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	5					5					
AAP347	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	40						20	20			
AAP356	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	60								30	30	
AAP348	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	18										18
M-7. Module of final attestation													
ECA303	Writing and defending a doctoral dissertation	FA	12										12
	Total based on UNIVERSITY:							30	30	30	30	30	30
								60		60		60	

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	5	25
PD	Cycle of profile disciplines		10	10	20
	Total for theoretical training:	*0*	*30*	*15*	*45*
	RWDS				*123*
FA	Final attestation	12			12
	TOTAL:	12	30	15	180

Decision of the Academic Council of Kaznu named after K.Satpayev. Protocol № 12 " 22 " april 2024 y.

Decision of the Educational and Methodological Council of Kaznu named after K.Satpayev. Protocol № 6 "19" april 2024 y.

Decision of the Academic Council of the Institute Automation and Information Technology. Protocol № 8 from "29" february 2024 y.

Vice-Rector for Academic Affairs — R.K. Uskenbayeva

Directors of the Institute of Automation and Information Technology — Z.B. Kalpeyeva

Head of the Department of Robotics and Automation Equipment — K.A. Ozhikenov

Specialty Council representative from employers — A.K. Dzhumagulov