SATBAYEV UNIVERSITY

Institute of «Automation and Information Technology»
Department «Robotics and Engineering Tools of Automation»

EDUCATIONAL PROGRAM
8D07106 «Robotics and Mechatronics»

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 2025

Educational program 8D07106 «Robotics and mechatronics» 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 8D07106 «Robotics and mechatronics» was developed by Academic committee for the educational field 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:				
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Berdibayeva Gulmira	Ph.D.	Associate professor of the department	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	
Kurmangaliyeva Lazzat	Candidate of technical sciences	Associate professor of the department	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	
Alimbaev Chingiz Abdraimovich	Ph.D.	Associate professor of the department	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	
Bigaliyeva Zhanar Serykhanovna	Master of Technical Sciences	Senior lecturer of the department	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	
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Students				
Shylmyrza Ussen	1st year doctoral student	8D07105 «Biomedical engineering»	Department of «Robotics and Engineering Tools of Automation», K.I. Satbayev KazNRTU	

Table of contents

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:

Ensuring the training of highly qualified specialists capable of developing innovative solutions in biomedical engineering, including robotic technologies, artificial intelligence, and sustainable development of the medical industry.

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;
- developing digital competencies and integrating AI into biomedical systems;
- forming skills in big data analysis in biomedical engineering;
- creating and implementing sustainable technologies for biomedical device manufacturing;
- applying global standards for the safety and efficiency of biomedical equipment;
- strengthening international cooperation and integrating global technologies into the national industry.

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

Requirements for Completion of Studies and Obtaining a Diploma Persons who have mastered the educational program of doctoral studies and defended a doctoral dissertation, subject to a positive decision of the dissertation councils of the higher education institution with special status or the Committee for Control in the Sphere of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan based on the results of the examination, are awarded the degree of Doctor of Philosophy PhD or doctor in the profile and are issued a state diploma with an appendix (transcript). Persons who have received the degree of PhD, in order to deepen their scientific knowledge, solve scientific and applied problems on a specialized topic, complete a postdoctoral program or conduct scientific research under the supervision of a leading scientist chosen by the higher education institution.

3.1 Requirements for the key competencies of doctoral graduates:

1) have an idea of: – the main stages of development and paradigm shifts in the evolution of science; – the subject, ideological and methodological specifics of the natural (social, humanitarian, economic) sciences; – about scientific schools of the relevant field of knowledge, their theoretical and practical developments; – about scientific concepts of world and Kazakhstani science in the relevant field; – about the mechanism of implementation of scientific developments in practical activities; – about the norms of interaction in the scientific community; – about the pedagogical and scientific ethics of a research scientist;

2) know and understand: – modern trends, directions and patterns of development of domestic science in the context of globalization and internationalization; – the methodology of scientific knowledge; – achievements of world and Kazakhstani science in the relevant field; – (be aware of and accept) the social responsibility of science and education; – perfectly speak a foreign language for scientific communication and international cooperation;

3) be able to: – organize, plan and implement the process of scientific research; – analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions; – analyze and process information from various sources; – conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis; – generate their own new scientific ideas, communicate their knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge; – select and effectively use modern research methodology; – plan and forecast their further professional development;

4) have the skills of: – critical analysis, evaluation and comparison of various scientific theories and ideas; – analytical and experimental scientific activity; – planning and forecasting research results; – oratory and public speaking at international scientific forums, conferences and seminars; – scientific writing and scientific communication; – planning, coordination and implementation of scientific research processes; – systemic understanding of the field of study and demonstrate the quality and effectiveness of the chosen scientific methods; – participation in

scientific events, fundamental scientific domestic and international projects; – leadership management and team management; – responsible and creative attitude to scientific and scientific-pedagogical activities; – conducting patent searches and experience in transferring scientific information using modern information and innovative technologies; – protection of intellectual property rights to scientific discoveries and developments; – free communication in a foreign language;

5) be competent: – in the field of scientific and scientific-pedagogical activity in the context of rapid renewal and growth of information flows; – in conducting theoretical and experimental scientific research; – in setting and solving theoretical and applied problems in scientific research; – in conducting a professional and comprehensive analysis of problems in the relevant field; – in matters of interpersonal communication and human resources management; – in matters of university training of specialists; – in conducting an examination of scientific projects and research; – in ensuring continuous professional growth.

3.2 Requirements for the research and development work of a student in a Doctor of Philosophy PhD program:

1) compliance with the main issues of the doctoral educational program, on which the doctoral dissertation is defended;

2) is relevant and contains scientific novelty and practical significance;

3) is based on modern theoretical, methodological and technological achievements of science and practice; 4) is based on modern methods of processing and interpreting data using computer technologies;

5) is performed using modern methods of scientific research;

6) contains research (methodological, practical) sections on the main provisions being defended.

3.3 Requirements for the organization of practices: Practice is conducted with the aim of developing practical skills in scientific, scientific-pedagogical and professional activities. The educational program of doctoral studies includes:

1) pedagogical and research practice - for students in the PhD program;

2) industrial practice - for students in the specialized doctoral program. During the period of pedagogical practice, doctoral students are involved, if necessary, in conducting classes in the bachelor's and master's degrees. Research practice of a doctoral student is conducted with the aim of studying the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as consolidating practical skills, applying modern methods of scientific research, processing and interpreting experimental data in dissertation research. Industrial practice of a doctoral student is conducted in order to consolidate theoretical knowledge obtained during the training process and to improve professional level. The content of research and industrial practice is determined by the topic of the doctoral dissertation. Generally mandatory standard requirements for completing doctoral studies and awarding a PhD degree: mastering at least 110 academic credits of theoretical training and preparation for passing the state exam in the specialty and defending the dissertation.

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 ensuring the training of highly qualified specialists capable of developing innovative solutions in biomedical engineering, including robotic technologies, artificial intelligence, and sustainable development of the medical industry.
7	Type of EP	New
8	The level based on NQF	8
9	The level based on IQF	8
10	Distinctive features of EP	No
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 - Demonstrate a high level of professional activity while solving industrial and / or scientific problems, observing all the principles of legal and ethical standards, including in the field of intellectual property rights protection. EO2 – Designing intelligently controlled systems and robotic technologies in biomedical engineering considering sustainable development requirements. 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.
13	Education form	full-time
14	Period of training	3 year
15	Amount of credits	180
16	Languages of instruction	russian, Kazakh, english
17	Academic degree awarded	Doctor of Philosophy PhD
18	Developer and author	Ozhikenov K.A.

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.	Research methodology	Objective: to acquire knowledge about the laws, principles, concepts, terminology, content, and specific features of organizing and managing scientific research using modern scientometric methods. Content: the structure of technical sciences, the application of general scientific, philosophical, and specialized methods of scientific research, principles of organizing scientific research, methodological features of modern science, ways of developing science and scientific research, the role of technical sciences, informatics, and engineering research in theory and practice.	5			v	v	v	
2.	Academic writing	Objective: to develop academic writing skills and writing strategies for doctoral students in engineering and natural sciences. Content: fundamentals and general principles of academic writing, including: writing effective sentences and paragraphs, writing an abstract, introduction, conclusion, discussion, and references; in-text citation; preventing plagiarism; and preparing a conference presentation.	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					v	v
Cycle of basic disciplines Component of choice									
4.	Automated systems for processing biomedical	The goal of the discipline is to develop competencies in big data, cloud computing, and AI in biomedicine, implementing global sustainable development standards in biomedical data processing. Content: using	5			v			v

	information	cloud technologies for storing and analyzing biomedical data, applying AI in clinical information processing, and developing algorithms for personalized biomedicine and predictive analytics.							
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	v	v				
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' knowledge in the field of modern ideas about biomedical intelligent systems.	5		v	v			

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 the removal, processing and analysis of 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

5. Curriculum of educational program

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

APPROVED

Chairman of the Management Board-
Rector of KazNRTU named after K.Satpayev
_____ M.M. Begentaev
«___» _____ 2025 y.

CURRICULUM
of Educational Program on enrollment for 2025-2026 academic year
Educational program 8D07105 - "Biomedical engineering"
Group of educational programs D102 - "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 courses 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)													
CSE 322	Scientific research methods	BD UC	5	150	2/0/1	105	E	5					
LNG 305	Academic writing	BD UC	5	150	0/0/3	105	E	5					
M-2. Control systems module (optional component)													
ROB 318	Automated systems for processing biomedical information	BD CCH	5	150	2/0/1	105	Э	5					
ROB 328	Modern technologies of bioelectric control of systems												
MNG 349	Intellectual Property and the global market												
M-3. Intelligent systems module (optional component)													
ROB 324	Biomedical intelligent systems	PD, CCH	5	150	2/0/1	105	Э	5					
ROB 329	Intelligent machine vision systems												
M-4. Engineering module (optional component)													
ROB 325	Design of technical means for collecting, processing and analyzing biomedical signals	PD, CCH	5	150	2/0/1	105	Э	5					
ROB 314	Methods of mathematical processing of biomedical data												
M-5. Practice-oriented module													
AAP 350	Pedagogical practice	BD UC	10						10				
AAP 355	Research practice	PD UC	10							10			
M-6. Experimental research module													
AAP 336	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RW DS UC	5					5					
AAP 347	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RW DS UC	40						20	20			
AAP 356	Research work of a doctoral candidate, including internships and completion of a	RW DS UC	60								30	30	

	doctoral dissertation												
AAP 348	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RW DS UC	18										18
M-7. Module of final attestation													
ECA 303	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 Kazntu named after K.Satpayev. Protocol № from " ____" _____2025 y.
Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № from " ____" _____2025 y.
Decision of the Academic Council of the Institute Automation and Information Technology. Protocol № from " ____" _____2025 y.

Vice-Rector for Academic Affairs _____ **R.K. Uskenbayeva**

Acting Directors of the Institute of Automation and Information Technology _____ **E.G. Chinibayev**

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

Specialty Council representative from employers _____ **A.K. Dzhumagulov**