



**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 2022**





Educational program 8D07106-Robotics and mechatronics was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes #13 dated 28.04.2022

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

Minutes #7 dated 26.04.2022

Educational program 8D07106-Robotics and mechatronics was developed by Academic committee based on direction 8D071 Engineering and engineering trades.

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

The educational program for the preparation of a Doctor of Philosophy (PhD) has a scientific and pedagogical focus and involves fundamental educational, methodological and research training and in-depth study of problems and various processes in the relevant areas of science for the system of higher and postgraduate education and the scientific sphere.

A doctoral student in the direction of training "Robotics and Mechatronics" should be prepared for solving 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 the scientific and technical problem and the definition of goals and objectives for the design of robotic and mechatronic 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 robotic and mechatronic 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 robotics and mechatronics;

- solving economic and organizational problems of technological preparation of the production of robotic and mechatronic systems and the choice of systems for ensuring the environmental safety of production;

*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 robotic and mechatronic 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 in the creation of 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 activities 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 robotics and mechatronics, requiring highly qualified personnel;
- administrative and organizational activities in higher educational institutions and scientific organizations on the profile of training.

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 Ph.D. 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 robotics and mechatronics, ready to solve scientific, practical and theoretical tasks of professional activity in modern conditions.

### **Tasks of EP:**

- the direction of its activities to contribute 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 on the basis 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**

<b>Universal, social and ethical competencies (USEC)</b>	
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	generate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge
<b>Special and managerial competencies (S&amp;MC)</b>	
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 a feasibility study of projects for creating robotic and mechatronic systems, their subsystems and individual modules
S-5	Ability to critically analyze, present, protect, discuss and disseminate the results of their professional activities
<b>Professional competencies (PC)</b>	
PC-1	Analyze the state of scientific and technical problems and determine the goals and objectives of designing robotic and mechatronic systems based on the study of the world experience
PC-2	Decision-making based on project calculations and results of technical-economic and functional-cost analysis of the effectiveness of projected robotic and mechatronic 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 robotics and mechatronics
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, competitiveness, 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 robotics and mechatronics



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

**EO1** - To analyze the state of the scientific and technical problem and the definition of the goals and objectives of the design of robotic and mechatronic systems based on the study of world experience.

**EO2** – To determine the safety, environmental friendliness and economic efficiency of the implementation of the projected robotic and mechatronic systems, their individual modules and subsystems.

**EO3** – To 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 robotics and mechatronics.

**EO4** – Conduct independent research in the field of robotics and mechatronics and upgrade existing robotic and mechatronic systems, introduce new methods of digital signal processing with elements of artificial intelligence.

**EO5** – Design modern reliable blocks and devices, intelligently controlling executive and information-sensor modules of robotic and mechatronic systems and complexes.

**EO6** – Demonstrate high professional qualities and ethics when interacting with various stakeholders.

## 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	8D07106 Robotics and Mechatronics
5	Short description of educational program	Training of highly qualified specialists who are able to conduct research on innovative areas related to robotics and mechatronics' evolution 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 robotics and mechatronics, 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 «8D07106 Robotics and Mechatronics»
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
<b>Cycle of basic disciplines University component</b>									
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	The course aims to develop academic writing skills of doctoral students in engineering and natural sciences. The course focuses on fundamentals and general principles of academic writing for; -writing effective sentences and paragraphs; -the use of tenses in scientific works, as well as styles and punctuation; - writing an abstract, introduction, results, discussion, conclusion, literature and resources used; - citing in the text; - preventing plagiarism, and making a presentation at the conference.	5	v					v
<b>Cycle of basic disciplines Component of choice</b>									
3.	Microprocessor technology in mechatronics and robotics	The discipline is aimed at teaching the principles of control of mechatronic and robotic systems, at acquiring the skills to control various sensors and solve problems of microprocessor control. He studies the basic principles of building information-measuring systems and control systems based on open platforms of microcontrollers, develops skills in developing hardware and software for automated control systems and control of mechatronic and robotic systems.	5				v	v	
4.	Control systems of mechatronic and robotic complexes	The purpose of teaching the discipline is to systematize and integrate previously acquired knowledge in the special disciplines of master's training in relation to the tasks of designing control systems of multicomponent robotic and mechatronic complexes, developing the skills of integrated design of mechatronic systems.	5					v	

<b>Cycle of profile disciplines Component of choice</b>									
5.	Intelligent control of robotic systems	The discipline is aimed at studying the methods and means of modern information processing technology used in the synthesis of models of intelligent control systems to solve control problems for a poorly formalized object or a poorly formalized process of interaction with the external environment under conditions of incompletely defined input data.	5				v	v	
6.	Machine vision	The discipline is aimed at studying the main tasks and groups of machine vision methods used in modern technical vision. Theory and technology of creating machines that can detect, track and classify objects. As a scientific discipline, machine vision refers to the theory and technology of creating artificial systems that receive information from images.	5				v	v	
7.	Designing modern humanoid robots	As part of the course, the doctoral student acquires practical skills in the development and design of robots in a computer environment. Basic knowledge and skills in computer science, programming and mathematics are offered. At the end of the course, the doctoral student must demonstrate the ability to analyze, design and develop special-purpose robots.	5	v	v			v	
8.	Designing mechatronic systems in Matlab/Simulink	The purpose of teaching the discipline is a practical study of the means and methods used in the simulation of technical systems, systematization and integration of previously acquired knowledge in the professional disciplines of master's training in relation to the tasks of designing mechatronic and robotic systems for special purposes. In this course it is supposed to acquaint doctoral students with modern methods of imitational and mathematical modeling of complex systems, paying special attention to methods created on the basis of artificial intelligence.	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 Kazntu named after K.Satpayev

\_\_\_\_\_ M.M. Begentaev  
« \_\_\_\_ » \_\_\_\_\_ 2022  
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### CURRICULUM

of Educational Program on enrollment for 2022-2023 academic year

Educational program 8D07106 - "Robotics and mechatronics"

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 courses and semesters					
								1 course		2 course			
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester
<b>M-1. Module of basic training (university component)</b>													
ROB327	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					
<b>M-2. Control systems module (optional component)</b>													
ROB321	Microprocessor technology in mechatronics and robotics	БД KB	5	150	2/0/1	105	Ә	5					
ROB308	Control systems of mechatronic and robotic complexes												
<b>M-3. Intelligent systems module (optional component)</b>													
ROB322	Intelligent control of robotic systems	ПД, KB	5	150	2/0/1	105	Ә	5					
ROB300	Machine vision												
<b>M-4. Engineering module (optional component)</b>													
ROB326	Designing modern humanoid robots	ПД, KB	5	150	2/0/1	105	Ә	5					
ROB303	Designing mechatronic systems in Matlab/Simulink												
<b>M-5. Practice-oriented module</b>													
AAP350	Pedagogical practice	BD UC	10						10				
AAP355	Research practice	PD UC	10							10			
<b>M-6. Experimental research module</b>													
AAP336	Research work of a doctoral candidate, including internships	RWD S UC	5					5					

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

	and completion of a doctoral dissertation													
AAP347	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWD S UC	40						20	20				
AAP356	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWD S UC	60								30	30		
AAP348	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWD S UC	18										18	
<b>M-7. Module of final attestation</b>														
ECA303	Writing and defending a doctoral dissertation	FA	12										12	
<b>Total based on UNIVERSITY:</b>									30	30	30	30	30	30
									<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
BD	Cycle of basic disciplines		20	5	25
PD	Cycle of profile disciplines		10	10	20
	<b>Total for theoretical training:</b>	<b>0</b>	<b>30</b>	<b>15</b>	<b>45</b>
	RWDS				<b>123</b>
FA	Final attestation	12			12
	<b>TOTAL:</b>	<b>12</b>	<b>30</b>	<b>15</b>	<b>180</b>

**Remark:**

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

Decision of the Academic Council of Kazntu named after K.Satpayev. Protocol № \_\_\_ or "\_\_\_" \_\_\_ 20\_\_ y.

Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № \_\_\_ or "\_\_\_" \_\_\_ 20\_\_ y.

Decision of the Academic Council of the Institute of A&IT. Protocol № \_\_\_ or "\_\_\_" \_\_\_ 20\_\_ y.

Vice-Rector for Academic Affairs

Director of the Institute of Automation and Information Technology

Head of the Department of Robotics and Automation Equipment

Specialty Council representative from employers

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

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

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

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