Institute of Automation and Information Technologies department
"Automation and control"

EDUCATIONAL PROGRAM
7M07114 - AUTOMATION AND ROBOTIZATION

code and name of the educational program

Code and classification of the field of education: 7M07 Engineering, manufacturing and construction industries
Code and classification of areas of study: 7M071 Engineering and Engineering
Group of educational programs: M100 Automation and control
NQF level: 7
ORC level: 7
Study period: 1.5 years
Volume of loans: 90 credits

Almaty 2023

Educational program **7M07114 - Automatization and Robotization** was approved at the meeting of the Academic Council of KazNITU named after K.I. Satpayev.

Protocol № 3 of «27» 10 2022

Reviewed and recommended for approval at the meeting of the Teaching and Methodological Council of KazNITU named after K.I. Satpayev.

Protocol № 2 of «21» 10 2022

The educational program **«7M07114 - Automatization and Robotization»** has been developed by the academic committee of **«7M071 Engineering and Engineering»**.

FULL NAME	Scientific degree/ academic title	Position	Workplace	Caption
Chairman of the Academic Committee:				
Aldiyarov Nakhypbek	Candidate of Physical and Mathematical Sciences	Head of the Department "Automation and Control"	NAO "Kazakh National Research Technical University named after K.I.Satpayev", cell phone: +77772746301	
Teaching staff:				
Suleimenov Batyrbek	Doctor of Technical Sciences	Professor	NAO "Kazakh National Research Technical University named after K.I.Satpayev", cell phone: +77017013722	
Beisembayev Akambay	Candidate of Technical Sciences, docent	Associate Professor	NAO "Kazakh National Research Technical University named after K.I.Satpayev", cell phone: +77783337261	
Sarsenbayev Nurlan	Candidate of Technical Sciences	Associate Professor	NAO "Kazakh National Research Technical University named after K.I.Satpayev", cell phone: +77055716781	

Shiryayeva Olga	Candidate of Technical Sciences	Associate Professor	NAO "Kazakh National Research Technical University named after K.I.Satpayev", cell phone: +77776470154	
Kulakova Elena	PhD	Senior Lecturer	NAO "Kazakh National Research Technical University named after K.I.Satpayev", cell phone: +77771853069	
Employers:				
Abdigaliyev Serik		Chief	«HONEYWELL - AUTOMATIC CONTROL SYSTEM LLP»	
Zikirbai Kuanysh	PhD	Head of Innovation and Information Technology Department	Saiman Corporation LLP, cell phone: +77716005070	

Table of contents

	List of abbreviations and symbols	5
1.	Description of the educational program	6
2.	Purpose and objectives of the educational program	7
3.	Requirements for evaluating the learning outcomes of an educational program	7
4.	Passport of the educational program	9
4.1.	General information	9
4.2.	The relationship between the attainability of the formed learning outcomes in the educational program and academic disciplines	eleven
5.	Curriculum of the educational program	16
6.	Additional educational programs (Minor)	18

List of abbreviations and symbols

OP	Educational program
LSG	Microprocessor control systems
RFP	Application package

1. Description of the educational program

The educational program (hereinafter EP) is a set of documents developed by the Kazakh National Research Technical University named after K.I. Satpayev and approved by the Ministry of Education and Science of the Republic of Kazakhstan.

Educational program 7M07114 - «Automatization and Robotization» involves the training of highly qualified specialists in the field of automation, robotics, artificial intelligence and automated control.

The bachelor's degree in the EP «Automatization and Robotization» provides for the acquisition of competencies in a wider area: automation, robotics, artificial intelligence and automated control in order to ensure the adaptation of bachelor's graduates to the requirements of the labor market. This EP of the master's program provides for further deepening of the competencies acquired in the bachelor's degree. In this connection, modern innovative disciplines have been introduced into the program for each of the trajectories.

In the process of mastering the educational program, the Master of Technical Sciences in the field of automation of production processes must acquire the following key competencies:

- will be able to analyze literature data and, on the basis of the analysis, determine and experimentally implement possible ways to modernize automated and robotic systems using new technical solutions.
- will be able to apply appropriate methods of analysis, both qualitative and quantitative, to collect and integrate information in the best possible way.
- will be able to conduct independent original research that contributes to the development of science, in accordance with the best practices and industry standards.
- have the skills to create robotic systems and automated technological complexes.
- have professional knowledge in the field of automation, robotization, artificial intelligence and automated control.

Objects of professional activity:

- automation and process control systems;
- robotic systems and complexes;

The Master in Automation of Production Processes must solve the following tasks in accordance with the types of professional activity:

in the field of production and technological activities:

- to be a leading engineer, a leading specialist of the production unit for the operation, maintenance, repair and adjustment of technical means of automated control systems for production processes in various industries;

in the field of organizational and managerial activities:

- to be the head of the department for the maintenance and repair of elements, devices of automated control systems for production processes in various industries;

in the field of experimental research activities:

- to be a leading specialist in conducting experimental studies of industrial automation objects;

in the field of research and teaching activities:

- be a researcher in a scientific laboratory for the research and development of modern automated control systems for production processes in various industries;

in the field of design design activities:

- be a leading engineer or chief engineer of a project for the development and design of automated control systems for production processes in various industries.

2. Purpose and objectives of the educational program

Purpose of the OP: The purpose of the educational program is to train undergraduates in basic and specialized disciplines with the achievement of relevant competencies.

Tasks of the OP:

Based on the achievements of modern science, technology and production, to provide knowledge and skills in the field of:

- automation;
- robotics;
- artificial intelligence;
- automated control.

3. Requirements for evaluating the learning outcomes of an educational program

OP 7MO7114 - «Automatization and Robotization» ensures that all students achieve the learning outcomes necessary for professional activities. At the end of the program, the student must:

- freely use in professional activities of the state, Russian and one of the most common, foreign language.
- master the main methods: data mining, descriptive analysis, correlation and regression analysis, classical calculus of variations, matrix description of spatial mechanisms.
- to master the main methods of modern control theory: synthesis of systems with a given dynamics using standard and relay controllers, digital control systems, systems with variable structure, modal control, identification and adaptation and optimal control.
- freely master the basics of philosophical, pedagogical, economic knowledge.
- possess the skills of describing the kinematics and dynamics of industrial robots, methods of developing software trajectories, developing adaptive and non-adaptive control algorithms for industrial robots.
- to have the skills to create automated process control systems and robotic

technological complexes.

- knowledge of modern technical means of automation and robotics. Own the basics of the practical application of modern technical means of automation.

- to possess the skills of building microprocessor systems (MSU). To be able to design hardware and software of MSU.

- possess the skills of software and stabilizing, optimal and adaptive control and synthesis of intelligent control systems.

- to possess the skills to conduct research and design work on the development of automated process control systems and robotic technological systems in various industries.

4. Passport of the educational program

4.1.General information

No.	Field name	Note
1	Code and classification of the field of education	7M07 Engineering, manufacturing and construction industries
2	Code and classification of areas of study	7M071 Engineering and Engineering
3	Group of educational programs	M100 Automation and control
4	Name of the educational program	7M07114 - Automation and robotization
5	Brief description of the educational program	Educational program 7M07114 - Automation and robotics involves the training of highly qualified specialists in the field of automation, robotics, artificial intelligence and automated control.
6	Purpose of the OP	The purpose of the educational program is to train undergraduates in basic and specialized disciplines with the achievement of relevant competencies.
7	OP type	New OP
8	NQF level	7
9	ORC level	7
10	Distinctive features of the OP	Not
11	List of competencies of the educational program:	In the process of mastering the educational program, the Master of Technical Sciences in the field of automation of production processes must acquire the following key competencies: - will be able to analyze literature data and, on the basis of the analysis, determine and experimentally implement possible ways to modernize automated and robotic systems using new technical solutions. - will be able to apply appropriate methods of analysis, both qualitative and quantitative, to collect and integrate information in the best possible way.

		- will be able to conduct independent original research that contributes to the development of science, in accordance with the best practices and industry standards. - have the skills to create robotic systems and automated technological complexes. - have professional knowledge in the field of automation, robotization, artificial intelligence and automated control.
12	Learning outcomes of the educational program:	PO1 Freely use in professional activities of the state, Russian and one of the most common, foreign language. PO2 Master the main methods: data mining, descriptive analysis, correlation and regression analysis, classical calculus of variations, matrix description of spatial mechanisms. PO3 To master the main methods of modern control theory: synthesis of systems with a given dynamics using standard and relay controllers, digital control systems, systems with variable structure, modal control, identification and adaptation and optimal control. PO4 Freely master the basics of philosophical, pedagogical, economic knowledge. PO5 Possess the skills of describing the kinematics and dynamics of industrial robots, methods of developing software trajectories, developing adaptive and non-adaptive control algorithms for industrial robots. PO6 To have the skills to create automated process control systems and robotic technological complexes. PO7 Knowledge of modern technical means of automation and robotics. Own the basics of the practical application of modern technical means of automation. PO8 To possess the skills of building microprocessor systems (MSU). To be able to design hardware and software of MSU. PO9 Possess the skills of software and stabilizing, optimal and adaptive control and synthesis of intelligent control systems. PO10 To possess the skills to conduct research and design work on the development of automated process control systems and robotic technological systems in various industries.
13	Form of study	full-time
14	Training period	1.5 years
15	Volume of loans	90 credits
16	Languages of instruction	Kazakh, Russian
17	Awarded Academic Degree	Master of Engineering
18	Developer(s) and authors:	Aldiyarov N.U., Zhanabaeva E.Zh.

4.2. The relationship between the achievability of the formed learning outcomes in the educational program and academic disciplines

No.	Name of the discipline	Brief description of the discipline	Number of credits	Formed learning outcomes (codes)									
				PO1	PO2	PO3	PO4	RO5	RO6	RO7	RO8	RO9	RO10
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. The course ends with a final exam. Undergraduates also need to study independently (MIS).	2	v									
2	Psychology of management	The course is aimed at mastering the tools for effective employee management, based on knowledge of the psychological mechanisms of the manager's activi ty. Discipline will help you master the skills of making decisions, creating a favorable psychological climate, motivating employees, setting goals, building a team and communicating with employees. At the end of the course, undergraduates will learn how to resolve managerial conflicts, create their own image, analyze situations in the field of managerial activity, as well as negotiate, be stress-resistant and effective leaders.	2				v						
3	Management	The purpose of the discipline is the formation of a scientific understanding of management as a form of professional activity; mastering the general theoretical provisions of the management of socio-economic systems by students; mastering the skills and abilities of practical solution of managerial problems; studying the world experience of management, as well as the peculiarities of Kazakhstani management, training in solving practical issues related to the management of various aspects of the activities of organizations.	2										v
Cycle of basic disciplines Optional component													
4	Modern control theory	The content of the discipline includes the study of modern approaches to the analysis and synthesis of automatic control systems based on the methodology of the "state space". The properties of linear and nonlinear systems and methods of their study are considered from the unified positions of the state space method. Basic information about systems with variable structure, modal control, identification, adaptation and optimization in	four			v							

		control systems is given.											
5	Integrated automation technology and management	The task of studying the discipline is to acquire knowledge on effective technologies for modeling automation objects, study directions for the development of automation tools, fundamentally new methods of process control, computer-integrated production of a new generation, as well as the acquisition of skills in the formation of a production automation strategy, the use of modern automation devices to solve control problems , the formation of sets of modern sensors and transducers to combine them into a system of computer-integrated production.	four						v		v		
6	Data Mining Methods	The discipline considers the most common methods and algorithms of data mining. Particular attention is paid to understanding the principles and concepts underlying modern intellectual methods. On practical examples, the features of data analysis during research in the field of automation and control are considered.	5		v								
7	Intelligent technologies in robotics	The course "Intelligent Technologies in Robotics" discusses the main characteristics of robots: load capacity, coordinate movement system, number of degrees of freedom; speed of movement and the magnitude of the stroke of each link, positioning error, method of installation at the workplace, working area of service. Classification and principles of construction of robotic systems. Technological requirements for robotic systems used in enterprises. An actively developing field of artificial intelligence. Includes models, methods and algorithms focused on automatic accumulation and formation of knowledge based on data analysis and generalization. Includes learning by example (or inductive) as well as traditional approaches from the theory of pattern recognition.	5					v	v			v	
Cycle of major disciplines University component													
8	Automation of engineering systems	The content of the discipline includes the methodological foundations for creating an automated system for technological preparation of production (APS). Taking into account the trends in the development of modern industrial production and new information technologies for its automation, the main principles for building the architecture of an IT system are formulated.	5						v		v		
9	Production practice	In order to consolidate and deepen the theoretical knowledge gained by students in the learning process, the acquisition of practical skills, competencies and professional experience in the educational program being taught, as well as the development of best practices, an internship is carried out. Students have practical training at enterprises, working directly at the workplaces of students, performing specific production tasks, consolidating theoretical knowledge. In the process of practice, practice leaders and	5	v									

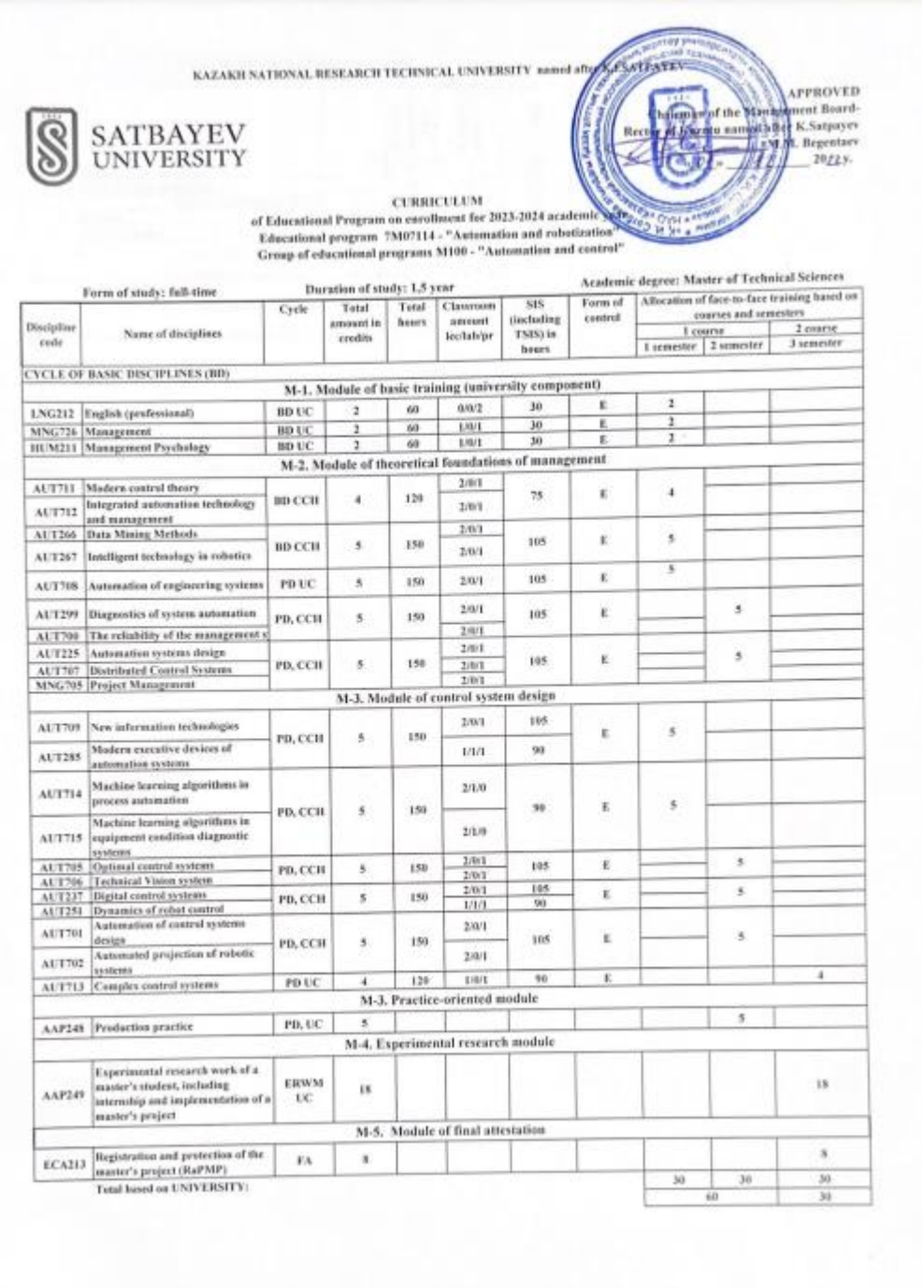
		appointed specialists at the workplace provide students with the necessary assistance and monitor (control) the process of internship in terms of meeting deadlines and content. The student keeps personal records of the practice in the practice diary.											
10	Complex control systems	Prerequisites: Automation of technical systems. Digital control systems. The purpose of the discipline - mastering the knowledge of modern technologies of automation and control of real multidimensional and multi-connected complex systems with several regulated circuits, as well as acquiring skills in the formation of automation strategy, the use of modern automation devices to solve problems of control of complex systems, solve the problems of modeling, analysis and synthesis of complex control systems. The purpose of teaching the discipline - the study of modern methods and principles of control of complex, multidimensional and multi-connected, systems.	4			v			v				
Cycle of major disciplines Selectable Component													
11	Diagnostics of elements of automation systems	The content of the discipline includes the characteristics of qualitative and quantitative indicators of the reliability of technical systems, their probabilistic and statistical evaluation based on test results, the study of the main methods for calculating the reliability of recoverable and non-recoverable systems, the analysis of the need and the choice of the redundancy rate, consideration of methods and models of technical diagnostics of automation systems. Training of specialists for independent solution of theoretical and applied problems related to the assessment, analysis, diagnostics and ensuring the reliability of systems.	5										v
12	Reliability of the control system and its elements	In the discipline "Reliability of the control system and its elements", the main terms, definitions and definitions in reliability calculations, quantitative indicators of the reliability of calculated and unacceptable technical systems, basic calculations of the reliability of complex systems, types of tests for reliability, issues of backup selection and determination of the reliability of backup systems are considered. . To consolidate theoretical materials, standard tasks are used. As well as issues of reliability of security and control systems.	5										v
13	Automation systems design	In the discipline, the stages of designing process control systems are studied. Methods of preparation of project documentation in accordance with modern international standards; methods of automating the construction of mathematical models, analysis and synthesis systems using modern computer technologies and automation of scientific research; trends in the development of science and technology and their impact on automation; The essence of a systematic approach in the design of modern hardware and software computing.	5										v

14	Distributed control systems	The content of the discipline "Distributed control systems" deals with the choice of structure and composition of hardware and software for distributed control systems. A distributed control system (DCS, DCS - Distributed Control System) can be defined as a system consisting of many devices spaced apart in space, each of which is independent of the others, but interacts with them to perform a common task. The maximum benefits of a distributed system are achieved when controllers work autonomously, and the exchange of information between them is minimized.	5			v						v	
15	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	
16	New information technologies	The course "New Information Technologies" discusses fundamental problems and mathematical methods of systems theory, characteristics of the stages of system analysis, system analysis procedures, data collection on the functioning of the system, the study of information flows, the construction of models of systems, checking the adequacy of models, uncertainty and sensitivity analysis, the study of resource capabilities, determining the goals of system analysis, the formation of criteria, generating alternatives, the implementation of choice and decision-making; Models of complex systems; Classification of types of modeling of complex systems, principles and approaches to the construction of mathematical models, stages of building a mathematical model, methods of qualitative evaluation of systems, methods of quantitative evaluation of systems, decision-making in conflict, risk, uncertainty, intelligent models in management.	5							v			
17	Modern executive devices of automation systems	In the content of the course, general issues of the theory of actuators of automation were considered, a decision was made to arrest actuators and their main characteristics, as well as issues related to actuators as an element of an automation system. The main goal of training is to teach the ability to choose the correct setting devices in automation systems, explaining that setting devices appear in automation systems.	5							v			
18	Optimal control systems (with AI elements)	The content of the discipline "Individual control systems" includes the study of mathematical methods of individual control based on the classical calculus of variations, the basics of maximum detection and the dynamic programming method. Models and methods of programmatic and stabilizing universal control are considered. Separate considerations of methods for the synthesis of intelligent systems of various control. Training of highly qualified personnel who know the basics of research and building optimal	5									v	

		control systems based on the methods of classical calculus of variations.											
19	Technical Vision systems (with AI elements)	In the discipline "Systems of technical vision", the main types of technical vision systems used in real-time control systems, the features of hardware and software technical vision, methods of organizing and conducting experimental research in the field of technical vision systems are considered. The methods of processing and transformation of inventions are being studied.	5							v			
20	Digital control systems	The content of the discipline "Digital Control Systems" includes the study of the mathematical apparatus for describing digital systems, describing digital systems in the time and frequency domains, and synthesizing digital controllers in the automation of production processes. Obtaining knowledge about the principles of construction and features of the use of digital control systems in industry.	5		v						v		
21	Dynamics of Robot Control	The content of the discipline "Dynamics of Robot Control" includes the study of mathematical approaches to cyclic, positional and contour control of industrial robots, models and algorithms for the kinematic and dynamic analysis of industrial robots, the study of the kinematics and dynamics of the manipulator and the drive system of an industrial robot.	5					v					
22	Automation of control system design	The content of the discipline "Automation of the design of control systems" includes the study of methods of analysis and synthesis of control systems, the choice of structure and the calculation of the parameters of the control law. The procedures for the analytical design of regulators, the development of structural, functional and other automation schemes using modern application software packages (APP) are considered. Mastering methods and algorithms for constructing mathematical models of objects and calculating modern automatic control systems.	5										v
23	Automated projection of robotic systems	The course "Automated design of robotic systems" considers the training of specialists who own the theoretical foundations of designing control systems and methods for performing experimental and computational work on the creation and operation of automation systems based on modern software and hardware.	5										v
24	Machine Learning Algorithms in Technological Process Automation	COURSE AIM AND OBJECTIVES The purpose of the discipline is to study methods of machine learning and analysis of big data for making management decisions in automated control systems of technological processes. The course focuses on determining the key variables of technological processes, identifying their interdependence and their impact on qualitative and quantitative indicators of production. Processing and analysis of large amounts of technological data. Particular attention is paid to machine learning algorithms that allow you to establish complex technological relationships without building complex mathematical models in conditions of uncertainty.	5		v								

25	Machine learning algorithms in equipment condition diagnostic systems	The purpose of the discipline is to analyze technological equipment in terms of diagnosing its condition and studying methods of machine learning and big data analysis to solve problems related to the identification of the technical condition of equipment. The course deals with the development of modern systems of equipment condition identification and strategies for maintenance and repair of equipment - according to the actual state. These systems are based on machine learning (ML) algorithms. Within the framework of the course the possibility of application of modern ML algorithms for equipment diagnostics, such as Decision Tree, Random Forest and others is considered. Python programming language is used to implement these algorithms.	5		v					v			

5. Curriculum of the educational program



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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board-
Rector of Kazntu named after K.Satpayev
_____ M.K. Begentaev
"__" _____ 2023 y.

CURRICULUM
of Educational Program on enrollment for 2023-2024 academic year
Educational program 7M07114 - "Automation and robotization"
Group of educational programs M100 - "Automation and control"

Form of study: full-time | Duration of study: 1,5 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
CYCLE OF BASIC DISCIPLINES (BD)										
M-1. Module of basic training (university component)										
LNG212	English (professional)	BD UC	2	60	0/0/2	30	E	2		
MNG726	Management	BD UC	2	60	1/0/1	30	E	2		
HUM211	Management Psychology	BD UC	2	60	1/0/1	30	E	2		
M-2. Module of theoretical foundations of management										
AUT711	Modern control theory	BD CCH	4	120	2/0/1	75	E	4		
AUT712	Integrated automation technology and management				2/0/1					
AUT266	Data Mining Methods	BD CCH	5	150	2/0/1	105	E	5		
AUT267	Intelligent technology in robotics				2/0/1					
AUT708	Automation of engineering systems	PD UC	5	150	2/0/1	105	E	5		
AUT299	Diagnostics of system automation	PD, CCH	5	150	2/0/1	105	E		5	
AUT700	The reliability of the management s				2/0/1					
AUT225	Automation systems design	PD, CCH	5	150	2/0/1	105	E		5	
AUT707	Distributed Control Systems				2/0/1					
MNG705	Project Management				2/0/1					
M-3. Module of control system design										
AUT709	New information technologies	PD, CCH	5	150	2/0/1	105	E	5		
AUT285	Modern executive devices of automation systems				1/1/1	90				
AUT714	Machine learning algorithms in process automation	PD, CCH	5	150	2/1/0	90	E	5		
AUT715	Machine learning algorithms in equipment condition diagnostic systems				2/1/0					
AUT705	Optimal control systems	PD, CCH	5	150	2/0/1	105	E		5	
AUT706	Technical Vision system				2/0/1					
AUT227	Digital control systems	PD, CCH	5	150	2/0/1	105	E		5	
AUT251	Dynamics of robot control				1/1/1	90				
AUT701	Automation of control systems design	PD, CCH	5	150	2/0/1	105	E		5	
AUT702	Automated projection of robotic systems				2/0/1					
AUT713	Complex control systems	PD UC	4	120	1/0/1	90	E			4
M-3. Practice-oriented module										
AAP248	Production practice	PD, UC	5						5	
M-4. Experimental research module										
AAP249	Experimental research work of a master's student, including internship and implementation of a master's project	ERWM UC	18							18
M-5. Module of final attestation										
ECA213	Registration and protection of the master's project (RaPMP)	FA	8							8
Total based on UNIVERSITY:								30	30	30
								60		30

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
			university component (UC)	component of choice (CCD)	Total
BD	Cycle of basic disciplines		6	9	15
PD	Cycle of profile disciplines		14	35	49
	Total for theoretical training:	*0*	*20*	*44*	*64*
	ERWM	*18*			*18*
FA	Final attestation	8			8
	TOTAL:	26	20	44	90

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 АаЭТ. Protocol № 2 от "20" 09 2022 y.

Vice-Rector for Academic Affairs — B.A. Zhautikov

Institute Director of AaIT — R.K. Uskenbayeva

Department Head of AaC — N.U. Abilyarov

Representative of the Council from employers — S.K. Abdigaliyev

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 development additional educational programs (Minor)