



**SATBAYEV
UNIVERSITY**

Mining and Metallurgical Institute named after O.A. Baikonurov

Department of Metallurgy and Mineral Processing

EDUCATIONAL PROGRAM

**7M07231 – « Automation and digitalization of metallurgical
processes»**

Code and classification of the field of education:	7M07 – Engineering, manufacturing and construction industries
Code and classification of training directions:	7M072 – Manufacturing and processing industries
Group of educational programs:	M117 – «Metallurgical Engineering»
Level based on NQF:	7
Level based on IQF:	7
Study period:	1,5 years
Amount of credits:	90

Almaty 2025

Educational program «7M07231 – Automation and digitalization of metallurgical processes» was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Protocol № 4 dated « 12 » 12 2024y.

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

Protocol № 3 dated « 20 » 12 2024y.

Educational program «7M07231 – Automation and digitalization of metallurgical processes» was developed by Academic committee based on direction «7M072 – Manufacturing and processing industries»

Full name	Academic degree/academic title	Position	Workplace	Signature
Chairperson of Academic Committee:				
Barmenshinova M.B.	c.t.s., associate professor	Head of the Department of MaMP	K.I. Satbayev KazNRTU	
Teaching staff:				
Moldabayeva G.Zh.	c.t.s., associate professor	Professor of the Department of MaMP	K.I. Satbayev KazNRTU	
Ussoltseva G.A.	c.t.s.	Associate professor of the Department of MaMP	K.I. Satbayev KazNRTU	
Employers:				
Ospanov E.A.	d.t.s.	Head of Department of complex processing of technogenic raw materials	«Kazakhmys Corporation» LLP	
Students:				
Sagyndyk A.N.	bachelor of engineering and technology	2 nd year master's student	«Kaz Minerals» LLP	

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List of abbreviations and designations

NCJS «Kazakh National Research Technical University named after K.I. Satpayev» – NCJS KazNITU named after K.I. Satpayev;

TSCSE – The State compulsory standard of education of the Republic of Kazakhstan;

MES RK – Ministry of Education and Science of the Republic of Kazakhstan;

EP – educational program;

IWS – independent work of a student (student, undergraduate, doctoral student);

IWSWT – independent work of a student with a teacher (independent work of a student (undergraduate, doctoral student) with a teacher);

WC – working curriculum;

CED – catalog of elective disciplines;

UC – university component;

CC – component of choice;

NQF – National Qualifications Framework;

IQF – Industry qualifications framework;

LO – learning outcomes;

KC – key competencies.

SDGs – sustainable development goals

1. Description of educational program

The educational program 7M07231 – "Automation and digitalization of metallurgical processes" covers industry-specific, priority, fundamental, natural science, general technical and professional training of masters in the field of automation and digitalization of metallurgical processes related to the introduction, operation and modernization of databases as the basis for managing the lifecycle of products used in metallurgical processes.

The educational program 7M07231 – "Automation and digitalization of metallurgical processes" is intended for specialized training of undergraduates and was developed within the framework of the direction "Manufacturing and processing industries".

Training of qualified specialists in the field of metallurgy, capable of designing, developing, managing and operating engineering systems and calculations, taking into account the criteria of sustainable development, environmental and social responsibility, as well as management principles within the framework of the ESG and the Sustainable Development Goals (SDGs).

Types of professional activity. Graduates of the Master's degree program can perform the following types of professional activities: design, production and technological, organizational and managerial, scientific and research.

A distinctive feature of the master's degree program (1.5 years of study) is that the educational program provides basic, professional knowledge, skills and abilities in metallurgical processing of mineral raw materials, as well as modern control systems; modern methods and software tools for research and design of automation systems of technological processes; modern technical means used when automating production processes.

The mission of the Master's degree program is to develop students' professional competencies that enable graduates to successfully solve production, technological, organizational, managerial, and design tasks in the field of automation and digitalization of metallurgical processes.

Objects of professional activity. The objects of professional activity of graduates are enrichment plants, enterprises of ferrous and non-ferrous metallurgy, chemical, mining, chemical and machine-building industries, branch research and design institutes, factory laboratories, higher and secondary professional educational institutions, government authorities and organizations of various organizational and legal forms.

The subjects of professional activity are technological automated control systems, digital technologies and techniques, quality control of final products, automation and digitalization of the processes of processing raw materials and the production of metal products with increased consumer properties.

Types of economic activity: automation and digitalization of mineral processing processes, production of metals from ores and man-made raw materials.

The education level code is 07 Engineering, Manufacturing and construction industries, 7 Technical Sciences and Technologies, 7M072 - Manufacturing and

processing industries.

2. Purpose and objectives of educational program

The purpose of the program is to enable master's students to acquire basic scientific foundations for the design, maintenance, and operation of metallurgical process automation systems; study and master modern methodology, technology, and tools related to the implementation, functioning, and modernization of databases as a basis for managing the product life cycle in relation to metallurgical processes; possess basic knowledge of sustainable mineral raw material processing technologies; automate and manage in accordance with the ESG concept and Sustainable Development Goals (SDGs), considering the principles of inclusive education, systematic, ecological, and critical thinking, teamwork, and communication.

The educational program "Automation and Digitalization of Metallurgical Processes" is aimed at training specialists with expertise in modern automation methods, digital technologies, and artificial intelligence in the metallurgical industry. Its objectives align with several key United Nations Sustainable Development Goals (SDGs).

Program Goals in the Context of the SDGs

1. SDG 4 – Quality Education
 - Developing students' digital competencies in the field of metallurgy.
 - Implementing innovative educational methodologies, including simulation models and virtual laboratories.
 - Concept of Inclusive Education.
2. SDG 9 – Industry, Innovation, and Infrastructure
 - Developing intelligent control systems for metallurgical processes.
 - Implementing automated production complexes and digital twins of metallurgical enterprises.
3. SDG 12 – Responsible Consumption and Production
 - Optimizing technological processes to reduce waste and energy consumption.
 - Introducing zero-waste production principles using digital technologies.
4. SDG 13 – Climate Action
 - Utilizing digital technologies for emission monitoring and energy efficiency improvement.
 - Automating environmental impact monitoring in metallurgical production.

The tasks of educational program are:

1. The competence of graduates in the automation and digitalization of metallurgical processes to increase technology productivity and improve the quality of products.
2. Development of practical skills and competencies to implement engineering solutions that contribute to achieving the SDGs in the field of responsible resource consumption and production.
3. The competence of graduates in the implementation of the development

and implementation of technological processes for processing mineral, natural and man-made raw materials;

4. The competence of graduates in assessing innovation and technological risks in the implementation of new digital technologies;

5. The competence of graduates in the system of digitalization of metallurgical industries. Acquisition of competencies in production management at all stages of the product lifecycle.

The Master of Technical Sciences in the field of 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 in the production department for the operation, maintenance, repair and adjustment of technical means of automated control systems for production processes in various industries, including metallurgy;

in the field of organizational and managerial activities:

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

in the field of experimental research activities:

- to be a leading specialist in conducting experimental studies of industrial automation facilities, including in metallurgy;

in the field of scientific research activities:

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

- to be a bachelor's degree teacher in special disciplines in the field of automation of production processes in metallurgy;

in the field of design and engineering 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, including metallurgy.

The educational program is fully developed to meet the objectives of the SDGs in metallurgy:

- Studying industrial control systems (SCADA, MES, ERP).

- Developing artificial intelligence and machine learning algorithms for metallurgy.

- Mastering Internet of Things (IoT) technologies and digital twins.

Developing competencies in sustainable metallurgical production:

- Analyzing and developing energy-efficient technologies.

- Implementing automated systems for emission and resource monitoring.

Training specialists for the future of digital metallurgy:

- Hands-on training in leading metallurgical enterprises.

- Developing and implementing innovative solutions to enhance productivity.

Integrating scientific research into the educational process:

- Engaging students in projects related to metallurgical digitalization.
- Applying new data processing methods and predictive analytics.

Inclusiveness and Accessibility:

- Creating conditions for the education of students with disabilities, adapting educational materials and environment.

Thus, the program aims to train highly qualified professionals capable of developing and implementing digital technologies in metallurgical production.

3. Requirements for evaluating the educational program learning outcomes

The program "Automation and digitalization of metallurgical processes" ensures the achievement of all necessary educational results for the professional activities of students.

Requirements for the key competencies of graduates of a specialized master's degree, must:

1) *have an idea:*

- the role of science and education in public life;
- about current trends in the development of scientific knowledge;
- on current methodological and philosophical problems of natural sciences;
- on the professional competence of a higher school teacher;
- contradictions and socio-economic consequences of globalization processes;
- about the latest discoveries in the chosen field of activity, the prospects of their use for the construction of technical systems and devices;
- mathematical and physical modeling of systems in the field of technology and equipment development;
- about design, research, inventive, innovative activities in the field of automation and digitalization of metallurgical processes;
- about the possibilities of advanced scientific methods and technical means, to use them at the level necessary for the study of mining and metallurgical processes and equipment.

2) *know:*

- current state and prospects of technical and technological development of automation and digitalization of metallurgical processes;
- the goals and objectives facing a specialist in the field of automation and digitalization of metallurgical processes for the development and implementation of the latest high-tech production technologies;
- methods of investigation of metallurgical processes, equipment operation;
- basic requirements for technical documentation of materials and products;
- rules and regulations of labor protection, issues of environmental safety of technological processes;
- methods of synthesis of automated control systems for metallurgical technological and production processes;
- current trends in the development of technical means and automation systems for metallurgical production processes;

- standards, methodological and regulatory materials accompanying the operation, installation, commissioning and design of automated production process control systems;

3) *be able to*:

- to develop technological processes for obtaining conditioned concentrates from ore, as well as metals from concentrates, processing metals and alloys, schemes of processing and metallurgical processes, to substantiate operating parameters and indicators;
- create a business plan for a technology project;
- to develop and research mathematical models and automation systems of production processes using modern software products;
- to develop algorithmic and software for micro-processor systems of automation of production processes;
- process data using planning techniques, regression and correlation analysis, and digitalization methods;
- to carry out measures for the organization of production in accordance with regulatory documents;
- to use the acquired knowledge for the original development and application of ideas in the context of scientific research;
- critically analyze existing concepts, theories and approaches to the analysis of processes and phenomena;
- integrate knowledge gained from different disciplines to solve research problems in new unfamiliar environments;
- by integrating knowledge, make judgments and make decisions based on incomplete or limited information;
- apply interactive teaching methods;
- to carry out information-analytical and information-bibliographic work involving modern information technologies;
- think creatively and be creative in solving new problems and situations;
- be fluent in a foreign language at a professional level that allows for scientific research and teaching of special disciplines in universities;
- summarize the results of scientific research and analytical work in the form of a dissertation, scientific article, report, analytical note, etc.;

4) *have the following skills*:

- organization of work on the development, installation, commissioning and operation of production process automation tools and systems;
- organization of work on the collection, storage and processing of information used in the field of professional activity.
- professional communication and intercultural communication;
- public speaking, the correct and logical formulation of their thoughts in oral and written form;
- expanding and deepening the knowledge necessary for daily professional activities and continuing education in doctoral studies.

5) *be competent*:

- in the field of scientific research methodology;

- in the field of scientific activity in higher education institutions;
- in matters of modern educational technologies;
- in carrying out scientific projects and research in the professional field;
- in ways to ensure continuous updating of knowledge, expansion of professional skills and abilities.

4. Passport of educational program

4.1. General information

№	Field name	Comments
1	Code and classification of the field of education	7M07 - Engineering, manufacturing and construction industries
2	Code and classification of training directions	7M072 - Manufacturing and processing industries
3	Educational program group	M117 – Metallurgical Engineering
4	Educational program name	7M07231 – Automation and digitalization of metallurgical processes
5	Short description of educational program	The educational program 7M07231 - "Automation and digitalization of metallurgical processes" covers industry-specific, priority, fundamental, natural science, general technical and professional training of masters in the field of automation and digitalization of metallurgical processes related to the introduction, operation and modernization of databases as the basis for managing the lifecycle of products used in metallurgical processes. The educational program 7M07231 - "Automation and digitalization of metallurgical processes" is intended for specialized training of undergraduates and was developed within the framework of the direction "Manufacturing and processing industries".
6	Purpose of EP	The purpose of the program is to enable master's students to acquire basic scientific foundations for the design, maintenance, and operation of metallurgical process automation systems; study and master modern methodology, technology, and tools related to the implementation, functioning, and modernization of databases as a basis for managing the product life cycle in relation to metallurgical processes; possess basic knowledge of sustainable mineral raw material processing technologies; automate and manage in accordance with the ESG concept and Sustainable Development Goals (SDGs), considering the principles of inclusive education, systematic, ecological, and critical thinking, teamwork, and communication.
7	Type of EP	New
8	The level based on NQF	7
9	The level based on IQF	7
10	Distinctive features of EP	no
11	List of competencies of educational program	1) <i>have an idea</i> : - about the role of science and education in public life; - about modern trends in the development of scientific

		knowledge; - about the professional competence of a higher school teacher. 2) <i>know</i>: – methodology of scientific knowledge; – principles and structure of organizing scientific activity; – goals and objectives facing a specialist in the field of mineral processing and metallurgy for the development and implementation of the latest high-tech production technologies; – methods for studying enrichment and metallurgical processes, equipment operation. 3) <i>be able to</i>: – develop energy- and resource-saving technologies in the field of mineral processing, metallurgy and metalworking; – develop measures to protect the environment for processing and metallurgical production; – plan experimental research, select research methods. 4) <i>have the skills</i>: – research activities, solving standard scientific problems; – carrying out educational and pedagogical activities on credit technology of education; - methods of teaching professional disciplines; – use of modern information technologies in the educational process; – professional communication and intercultural communication 5) <i>be competent</i>: - in the field of scientific research methodology; – in the field of scientific and scientific-pedagogical activities in higher educational institutions; - in matters of modern educational technologies; - in carrying out scientific projects and research in the professional field; - in ways to ensure constant updating of knowledge, expansion of professional skills and abilities.
12	Learning outcomes of educational program	LO1–To demonstrate communicative, professional and technical language knowledge in a foreign, professional language, knowledge of philosophical concepts of natural science, scientific worldview for the implementation of sustainable development. LO2– Master the basic methods of data mining, descriptive analysis, correlation and regression analysis, classical calculus of variations, matrix description of spatial mechanisms. LO3– Master the basic methods of modern control theory: synthesis of systems with a given dynamics using standard and relay controllers, digital control systems, variable structure systems, modal control, identification and adaptation of optimal control to create sustainable engineering solutions. LO4– Be able to develop technological processes for

		obtaining conditioned concentrates from ore, as well as metals from concentrates, processing metals and alloys, schemes of processing and metallurgical processes, substantiate operating parameters and indicators for the implementation of responsible resource consumption and production. LO5– Master the basic methods and theories of installation, commissioning and operation of production systems of metallurgical processes LO6–Possess the skills to perform calculations on thermodynamics and kinetics of metallurgical processes, substantiate the choice of processes and requirements for their hardware design, predict the indicators of certain specific processes and directions for the development of technologies for processing ore and man-made raw materials LO7–Integrate the psychological patterns of managerial activities, systemic and ecological thinking, synthesize skills in management psychology, critical thinking, leadership, teamwork, and communication in the context of inclusive education. LO8 – Project management skills for sustainable development. Proficiency in socio-psychological and managerial project management skills, the ability to independently acquire new knowledge, and professional argumentation skills for analyzing standard situations in the field of managerial activities (SDG 4). LO9 – Capable of applying modern, advanced knowledge of innovative technologies in the metallurgical complex: refining of radioactive and precious metals, corrosion of metals, powder metallurgy, processing of technogenic raw materials, sustainable and energy-saving pyrometallurgical and hydrometallurgical technologies with elements of digitalization and automation (SDG 7, 12). LO10–Is to integrate automated technological complexes of continuous production and robotic technological complexes in discrete production facilities to realize the development of innovative infrastructure.
13	Education form	Full - time
14	Period of training	1,5 years
15	Amount of credits	90
16	Languages of instruction	Kazakh, russian, english
17	Academic degree awarded	Master of Engineering and Technology in the educational program «7M07231 - Automation and digitalization of metallurgical processes»
18	Developers and authors	Barmenshinova M., Chepushtanova T.A.

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

№	Name of the discipline	Brief description of the discipline	Number of credits	Generated learning outcomes (codes)									
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10
Cycle of basic disciplines University component													
1	Foreign language (professional)	The purpose of the discipline is to acquire and improve competencies in accordance with trade standards of foreign education, capable of competing in the labor market, because through a foreign language, the future master gains access to academic knowledge, new technologies and modern information, allowing the use of a foreign language as a means of communication in the intercultural, professional and scientific activities of the future master.	2	√						√			
2	Psychology of management	To acquire skills in making strategic and managerial decisions, taking into account the psychological characteristics of the individual and the team. Content: the modern role and content of psychological aspects in management activities, methods for improving psychological literacy, the composition and structure of management activities, both at the local and foreign levels, the psychological feature of modern managers.	2							√	√		
3	Management	To form a scientific understanding of management as a type of professional activity. Contents: Mastering the general	2							√	√		

		theoretical principles of managing socio-economic systems; acquiring skills and abilities in practical problem-solving of managerial issues; studying global management practices and the specificities of Kazakhstani management; training in solving practical issues related to managing various aspects of organizational activities.											
4	Modern control theory	The content of the discipline includes the study of modern approaches for the analysis and synthesis of automatic control systems based on the “state space” methodology. The properties of linear and nonlinear systems and methods for their study are considered from a unified positions of the state space method. Provided basic information about systems with variable structure, modal control, identification, adaptation and optimization in control systems.	5			√				√	√		
Elective component													
5	Calculations of processes and apparatuses of extractive metallurgy	Acquisition of knowledge by undergraduate on the basic calculations of processes and technologies of extractive metallurgy, including calculations of material and balance flows of the main technologies of extractive metallurgy (copper production, radioactive and noble metals), taking into account resource and energy saving, selection and calculation of the main and auxiliary equipment.	4				√		√			√	
6	Intellectual property and research	The purpose of this course is to provide undergraduates with the knowledge and skills necessary to understand, protect and manage intellectual property (IP) in the context of											

		scientific research and innovation. The course is aimed at training specialists who can effectively work with IP, protect the results of scientific research and apply them in practice.											
7	Physical-chemical and thermodynamic processes in metallurgy	The goals and objectives of the discipline course are for undergraduates to acquire knowledge about the theoretical foundations of metallurgical processes, perform thermodynamic calculations of metallurgical processes, predict the performance of certain specific processes of processing ore and man-made raw materials, study physico-chemical processes in the processing of various mineral raw materials: thermodynamic analysis of Me-S-O systems, thermodynamics of exchange hydrometallurgical reactions, thermodynamics oxidative hydrometallurgical reactions, construction and analysis of Potential-pH diagrams, thermodynamics of autoclave processes.	4			✓	✓					✓	
Cycle of profile disciplines University component and elective component													
8	Modern executive devices of automation systems	The course content addressed general issues of the theory of automation actuators, outlined the properties of actuators and their main characteristics, as well as issues related to actuators as an element of an automation system. The main purpose of the training is to teach the ability to correctly select actuators in automation systems, explaining that actuators are an important element in automation systems.	5			✓						✓	✓

9	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		✓		✓						
10	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		✓	✓							
11	Project Management	Goal: Gaining knowledge about the components and methods of project management based on modern models and standards. Objectives: study of behavioral models of project-oriented management of business development; mastering international standards PMI PMBOK, IPMA ICB and national standards of the Republic of Kazakhstan in the field of project management; analysis of the features of organizational management of business development through the integration of	5							✓	✓		

		strategic, project and operational management.											
12	The theory of process of metallurgical engineering	Purpose: acquisition by master students of in-depth knowledge on the theory of metallurgical processes: pyro-, hydro- and electrometallurgy; on the prospects of theory development, on the practical use of theoretical provisions. Content: systematized materials on oxide melts, the structure and properties of slags, as well as the theoretical basis of hydrometallurgical and electrometallurgical processes, in-depth knowledge of methods of analysis of state diagrams of slag systems, diagrams "Potential - pH", the laws of electrometallurgical processes, as well as the basic laws of thermodynamics, mechanism and kinetics of the main metallurgical processes; examples of various processes of processing pyro- and hydro-electrometallurgical methods; methods and methods of the following	5				V		V			V	
13	Rational use of natural and man-made raw materials	The aims and objectives of the course is the acquisition of knowledge by undergraduates on the rational use of natural and man-made raw materials, waste-free technologies in metallurgy. The study of processing and disposal of waste from metallurgical production. Contribute to the formation of metallurgical technologies aimed at the greening of production. Rationing of waste generation and limits on their disposal. Review requirements for waste disposal sites, transportation of hazardous waste and	5				V		V			V	

		transboundary movement of waste.											
14	Corrosion and protection of structures in the metallurgical industry	The course presents the theoretical laws and practice of chemical and electrochemical corrosion in relation to metal structures, taking into account: the cross-section of different structures, streamlining, General layout and arrangement of structural elements. The methods of application and installation of thermal protection and insulation materials and other methods of corrosion protection, as well as examples of successful and unsuccessful design solutions.	5					✓	✓			✓	
15	Hardware design of processes for obtaining radioactive metals	The purposes of teaching discipline is training and training of specialists for production activities in the field of instrumental design of processes for obtaining radioactive metals and practical skills in the design of standard aggregates, which corresponds to the qualification character of the specialty.	5					✓	✓			✓	
16	Production of titanium sponge and magnesium. Titanium chemistry	The discipline covers the technological processes of obtaining spongy titanium and magnesium, including chlorination, reduction and refining. The chemical properties of titanium, its compounds, methods of purification and alloying are considered. Thermodynamics, kinetics of processes and modern production technologies are studied, as well as their application in industry.	5					✓				✓	
17	Diagnostics of system automation	The content of the discipline includes the characterization of qualitative and quantitative indicators of the reliability of technical systems, their probabilistic and statistical evaluation based on test results, the	5		✓							✓	✓

		study of basic methods for calculating the reliability of recoverable and non-recoverable systems, the analysis of the need and choice of redundancy multiplicity, consideration of methods and models of technical diagnostics of automation systems. Training specialists to independently solve theoretical and applied problems related to the assessment, analysis, diagnosis and reliability of systems.											
18	The reliability of the management system and its elements	The discipline "Reliability of the control system and its elements" examines the basic terms, definitions and definitions in reliability calculations, quantitative indicators of reliability of design and unacceptable technical systems, basic calculations of reliability of complex systems, types of reliability tests, issues of backup selection and determining the reliability of backup systems. . Standard tasks are used to consolidate theoretical materials. As well as issues of reliability of security and management systems.	5			✓		✓					✓
19	Digital control systems	The content of the disciplines "Digital control systems" includes the study of the mathematical apparatus of the description of digital systems, the description of digital systems in time and frequency form, the synthesis of digital regulators during the transfer of production processes. Gaining knowledge about the advantages and application features of digital control systems, the feasibility and performance conditions of digital control systems and their application in industrial processes.	5		✓	✓							✓

20	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			✓							✓
21	Innovative technologies of complex processing of titanium-containing raw materials	The discipline covers a wide range of issues related to the processing of titanium-containing materials, including ores, concentrates, and titanium production waste. The course covers key processes such as pyrometallurgy, hydrometallurgy, electrolysis, nanotechnology, and biotechnology. An important aspect of the course is the study of innovative technologies that allow solving problems related to waste disposal and improving the quality of	4				✓		✓			✓	

		products. Special attention is also paid to issues of sustainable development and environmental protection in the context of processing titanium-containing materials.											
22	Uranium conversion - the production of uranium hexafluoride	The discipline covers technologies for the conversion of uranium into uranium hexafluoride (UF ₆) for subsequent enrichment. The chemical processes of uranium fluorination, the equipment used, safety when working with radioactive substances and environmental aspects are considered. Undergraduates study radiation risk management methods and the specifics of UF ₆ production in the nuclear power industry.	4				✓		✓			✓	
23	Fundamentals of powder metallurgy	The course «Fundamentals of powder metallurgy» examines the fundamentals of technology for the production of powdered metals and alloys. The course focuses on methods for studying the properties of powdered metals and alloys, quality control methods for products made from them, and the use of metal powders and alloys to produce products with special properties. Formation of systematized knowledge, skills and abilities on methods of obtaining powdered metals and alloys.	5				✓		✓			✓	
24	Technologies and equipment in uranium production	The course provides for the study of the basics of processing uranium raw materials and the study of hardware design of uranium production. Metallurgy of uranium. Fundamentals of the technology of underground borehole leaching of uranium ores. Advantages of the PSV method.	5				✓	✓					✓

		Application of the PSV method. Designs of pumping and injection wells, their location schemes and operational features. The dependence of the efficiency of ore processing on the uranium content in it and the degree of its extraction during leaching. Comparison of economic indicators of underground and traditional leaching methods.											
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5. Curriculum of educational program

NON-PROFIT JOINT STOCK COMPANY
"KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY NAMED AFTER K.I. SATBAYEV"



«APPROVED»
Decision of the Academic Council
N PJSC «KazNRTU»
named after K. Satbayev»
dated 20.02.2025 Minutes № 9

WORKING CURRICULUM

Academic year

2025-2026 (Autumn, Spring)

Group of educational programs

MI17 - "Metallurgical Engineering"

Educational program

7M07231 - "Automation and digitalization of metallurgical processes"

The awarded academic degree

Master of engineering and technology

Form and duration of study

full time (professional track) - 1,5 years

Discipline code	Name of disciplines	Block	Cycle	Total ECTS credits	Total hours	lek/lab/pr Contact hours	in hours SIS (including TSIS)	Form of control	Allocation of face-to-face training based on courses and semesters			Prerequisites
									1 course		2 course	
									1 sem	2 sem	3 sem	
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)												
CYCLE OF BASIC DISCIPLINES (BD)												
M-1. Module of basic training												
LNG212	Foreign language (professional)		BD, UC	2	60	0/0/30	30	E	2			
MNG726	Management		BD, UC	2	60	15/0/15	30	E	2			
HUM211	Psychology of management		BD, UC	2	60	15/0/15	30	E	2			
MET768	Calculations of processes and apparatuses of extractive metallurgy	1	BD, CCH	4	120	30/0/15	75	E	4			
MET700	Physical-chemical and thermodynamic processes in metallurgy	1	BD, CCH	4	120	30/0/15	75	E	4			
MNG781	Intellectual property and research	2	BD, CCH	5	150	30/0/15	105	E	5			
M-2. Module of professional activity												
AUT703	Modern control theory		BD, UC	5	150	30/0/15	105	E	5			AUT115
CYCLE OF PROFILE DISCIPLINES (PD)												
M-1. Module of basic training												
AUT708	Automation of engineering systems	2	PD, CCH	5	150	30/0/15	105	E	5			
AUT225	Automation systems design	2	PD, CCH	5	150	30/0/15	105	E	5			AUT166
M-2. Module of professional activity												
AUT285	Modern executive devices of automation systems		PD, UC	5	150	15/15/15	105	E	5			AUT108
MET757	The theory of process of metallurgical engineering		PD, UC	5	150	30/0/15	105	E	5			
MET704	Rational use of natural and man-made raw materials	1	PD, CCH	5	150	30/15/0	105	E		5		
MET705	Corrosion and protection of structures in the metallurgical industry	1	PD, CCH	5	150	30/15/0	105	E		5		
MNG705	Project Management	1	PD, CCH	5	150	30/0/15	105	E		5		
MET202	Hardware design of processes for obtaining radioactive metals	2	PD, CCH	5	150	30/0/15	105	E		5		
MEI267	Production of titanium sponge and magnesium. Chemistry of titanium	2	PD, CCH	5	150	30/0/15	105	E		5		
AUT299	Diagnostics of system automation	3	PD, CCH	5	150	30/0/15	105	E		5		
AUT700	The reliability of the management system and its elements	3	PD, CCH	5	150	30/0/15	105	E		5		AUT112
AUT237	Digital control systems	4	PD, CCH	5	150	30/0/15	105	E		5		AUT102
AUT709	New information technologies	4	PD, CCH	5	150	30/0/15	105	E		5		
MET706	Fundamentals of powder metallurgy	5	PD, CCH	5	150	30/0/15	105	E		5		
MET707	Technologies and equipment in uranium production	5	PD, CCH	5	150	30/0/15	105	E		5		

MEI246	Innovative technologies of complex processing of titanium-containing raw materials	1	PD, CCH	4	120	30.0/15	75	E			4	
MEI247	Uranium conversion - the production of uranium hexafluoride	1	PD, CCH	4	120	30.0/15	75	E			4	
M-3. Practice-oriented module												
AAP248	Internship		PD, UC	5				R		5		
M-4. Experimental and research module												
AAP249	Experimental research work of a master student, including an internship and the implementation of a master's project		ERWMS	18				R			18	
M-5. Module of final attestation												
ECA213	Design and defense of the master's project		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			
		Required component (RC)	University component (UC)	Component of choice (CCH)	Total
GED	Cycle of general education disciplines	0	0	0	0
BD	Cycle of basic disciplines	0	11	4	15
PD	Cycle of profile disciplines	0	15	34	49
Total for theoretical training:		0	26	38	64
RWMS	Research Work of Master's Student				0
ERWMS	Experimental Research Work of Master's Student				18
FA	Final attestation				8
TOTAL:					90

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Minutes № 4 dated 03.02.2025

Decision of the Academic Council of the Institute. Minutes № 5 dated 23.01.2025

Signed:
 Governing Board member - Vice-Rector for Academic Affairs Uskenbayeva R. K.
Approved:
 Vice Provost on academic development Kalpeyeva Z. E.
 Head of Department - Department of Educational Program Management and Academic-Methodological Work Zhumagaliyeva A. S.
 Director - Mining and Metallurgical Institute named after O.A. Baikonurov Rysbekov K. .
 Department Chair - Metallurgy and mineral processing Barnershinova M. .
 Representative of the Academic Committee from Employers Ospanov Y. A.
 ____Acknowledged____

