Institute Mining and Metallurgical
Department of Metallurgical processes, Heat engineering and Technologies of special materials

EDUCATIONAL PROGRAM

7M07201-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:	Level 7 - Postgraduate education. Master's degree (based on the completed bachelor's program), practical experience
Level based on IQF:	Level 7 – Conceptual professional and/or scientific knowledge (including innovative) and experience in a specific area and/or at the intersection of areas. Assessment and selection of professional information. Creation of new applied knowledge in a specific area. Identification of sources and search for information necessary for the development of activities
Study period:	2 years
Amount of credits:	120

Almaty 2024

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

Educational program **7M07201- Automation and digitalization of metallurgical processes**

was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes № 12 dated «22» 04 2024.

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

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Educational program **7M07201 - Automation and digitalization of metallurgical processes** was developed by Academic committee based on direction **«Metallurgical Engineering»**

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F KazNRTU 703-05 Educational program

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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.

1. Description of educational program

The educational program 7M07201 - "Automation and digitalization of metallurgical processes" includes industry-specific, priority, fundamental, natural science, general engineering and professional training of masters in the field of automation and digitalization of metallurgical processes related to the implementation, operation and modernization of databases as the basis for product lifecycle management in relation to metallurgical processes.

It is intended for specialized training of undergraduates in the educational program 7M07201 - "Automation and digitalization of metallurgical processes" at Satbayev University and was developed within the framework of the direction "Manufacturing and processing industries".

This document meets the requirements of the following legislative acts of the Republic of Kazakhstan and regulatory documents of the Ministry of Education and Science of the Republic of Kazakhstan:

– The Law of the Republic of Kazakhstan "On Education" with amendments and additions in the framework of legislative amendments to enhance the independence and autonomy of universities dated 07/04/18, No. 171-VI;

– The Law of the Republic of Kazakhstan "On Amendments and Additions to Certain Legislative Acts of the Republic of Kazakhstan on the expansion of academic and managerial independence of higher education institutions" dated 07/04/18. No. 171-VI;

– Order of the Minister of Education and Science of the Republic of Kazakhstan dated 10/30/18 No. 595 "On approval of Standard Rules for the activities of educational organizations of relevant types";

– The State mandatory standard of higher education (Appendix 7 to the Order of the Minister of Education and Science of the Republic of Kazakhstan dated 31.10.18 №604;

– Resolution of the Government of the Republic of Kazakhstan dated January 19, 12, No. 111 "On approval of the Standard Rules for admission to study in educational organizations implementing educational programs of higher education" with amendments and additions dated July 14, 2016, No. 405;

– Resolution of the Government of the Republic of Kazakhstan dated December 27, 2019 No. 988 "On approval of the State Program for the Development of Education and Science of the Republic of Kazakhstan for 2020-2025";

– Resolution of the Government of the Republic of Kazakhstan dated 31.12.2019 No. 1050 "On approval of the State Program of Industrial and Innovative Development of the Republic of Kazakhstan for 2020-2025";

- "National Qualifications Framework", approved by the protocol dated 16.06.2016 of the Republican Tripartite Commission on Social Partnership and Regulation of Social and Labor Relations;

– Industry qualification framework "Mining and Metallurgical Complex" No. 1 dated 30.07.2019;

– Strategy "Kazakhstan-2050": a new political course of the established state. The Message of the President of the Republic of Kazakhstan - Leader of the Nation N.A. Nazarbayev to the people of Kazakhstan. Astana, 12/14/2012;

– "New development opportunities in the context of the Fourth Industrial Revolution". The Message of the President of the Republic of Kazakhstan N. Nazarbayev to the people of Kazakhstan. 10.01.2018;

– "The third modernization of Kazakhstan: global competitiveness". The Message of the President of the Republic of Kazakhstan N. Nazarbayev to the people of Kazakhstan. 31.01.2017

The duration of the master's degree is determined by the amount of academic credits acquired. Upon mastering the established amount of academic credits and achieving the expected learning outcomes for obtaining a master's degree, the Master's degree program is considered fully completed. The scientific and pedagogical master's degree program has at least 120 academic credits for the entire period of study, including all types of educational and scientific activities of the graduate student.

The planning of the content of education, the way of organizing and conducting the educational process is carried out by the university and the scientific organization independently on the basis of credit technology of education.

The Master's degree in scientific and pedagogical direction implements postgraduate educational programs for the training of scientific and scientific-pedagogical personnel for universities and scientific organizations with in-depth scientific, pedagogical and research training.

The content of the Master's degree program consists of:

1) theoretical training, including the study of cycles of basic and profile disciplines;

2) practical training of undergraduates: various types of practices, scientific or professional internships;

3) research work, including the implementation of a master's thesis, for scientific and pedagogical master's degree;

4) final certification.

The content of the educational program includes the following modules: general education, general engineering, engineering and technical and professional modules.

The educational program includes the following stages of undergraduates' training: English (professional), history and philosophy of science, management of educational and organizational activities (higher school pedagogy + management psychology); theory and calculations of metallurgical thermodynamics and kinetics; MES systems; digital control systems; microprocessor process control systems; diagnostics and reliability of automation systems; special chapters on heat transfer of metallurgical processes; modern management theory; waste management in the metallurgical industry; sustainable pyro- and hydrometallurgical technologies for processing mineral raw materials. Optimal control systems (with AI elements). Reliability of the control system and its elements. Resource and energy conservation in metallurgy. Automation of control system design. Distributed management

systems. Methods of analysis of metallurgical processes and metallurgical products. Design of automation systems. Numerical control systems for robots. The opportunity to choose subjects from the catalog of elective subjects of Satbayev University.

Types of professional activity

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

A distinctive feature of the master's degree program is that the educational program provides knowledge, skills and abilities in the metallurgical processing of mineral raw materials (metal production, tailings disposal, basic metal production technologies), as well as modern control systems, including digital, adaptive, optimal, microprocessor, intelligent; modern methods and software tools for research and design of automation systems of technological processes; about modern technical means used in automation of production processes.

The mission of the Master's degree program is to develop students' social and personal qualities and 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.

Types and subjects of professional activity.

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

Purpose of EP: The purpose of the educational program is to master the scientific foundations of building, maintaining and operating automation systems for metallurgical processes; to study and master modern methodology, technology and tools related to the implementation, operation and modernization of databases as the basis for product lifecycle management in relation to metallurgical processes; to possess basic knowledge of sustainable technologies for processing mineral raw materials; training undergraduates in basic and specialized disciplines with the achievement of relevant competencies.

Tasks of EP:

1. The competence of graduates in the automation and digitalization of metallurgical processes to increase technology productivity and improve the quality of products.

2. The competence of graduates in the implementation of the development and implementation of technological processes for processing mineral, natural and man-made raw materials;

3. Graduates' competence in assessing innovation and technological risks in the implementation of new digital technologies;

4. The competence of graduates in the system of digitalization of metallurgical processes. 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 and teaching 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 metallurgical production processes;

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.

3. Requirements for evaluating the educational program learning outcomes

A graduate of a scientific and pedagogical master's degree must: 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;
- about communicative, professional and technical language knowledge, about philosophical concepts of natural science, scientific worldview.
- about the patterns of managerial activity, systemic and environmental thinking, critical thinking, leadership, teamwork and communication.
- on teaching and mentoring skills for undergraduate students.
- design, research, inventive, and innovative activities in the field of mineral processing and metallurgy;
- on the principles of automation and digitalization of metallurgical processes.

To know:
- methodology of scientific knowledge;
- principles and structure of scientific activity organization;
- psychology of cognitive activity of students in the learning process;
- psychological methods and means of improving the effectiveness and quality of education;
- international and domestic standards, resolutions, orders, orders of higher-level and other domestic organizations, methodological normative and guidance materials related to the work performed;
- the current state and prospects of technical and technological development of enrichment and metallurgical processes, the specifics of the activities of institutions, organizations, enterprises and related industries;
- goals and objectives facing a specialist in the field of extractive and gentle metallurgy;
- modern research methods for processing and 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 conducting expert assessment in the field of life safety and environmental protection;
- standards in the field of quality management;
- achievements of science and technology, advanced domestic and foreign experience in the field of mineral processing and metallurgy;
- at least one foreign language at a professional level that allows for scientific research and practical activities;
- the methodology of conducting all types of training sessions and independent work of students.

be able to:

– show communicative, professional and technical language knowledge in a foreign, professional language.
– integrate the psychological patterns of managerial activity;
– demonstrate teaching and mentoring skills to undergraduate students;
– to study empirical data based on the methodology of scientific research for the ability to write articles, collect scientometric data, and protect intellectual property using the principles of project management;
– apply and implement fundamentally new schemes for the production of metals based on saving resources and preserving the environment, in conditions of ore depletion, reducing the concentration of metals in ores;
– solve engineering calculations in the field of extractive metallurgy, thermodynamics and kinetics of pyro- and hydrometallurgical processes;
– justify the choice of processes and requirements for the processes of rectification and condensation;
– to develop and research modern technologies for the production of energy-generating, radioactive, and refractory metals; to calculate and select the main and auxiliary equipment for hydro–, pyro–, and electrometallurgical processes in non-ferrous metallurgy, to calculate and predict electro- and metallothermal production of metals and alloys;
– to transform existing technologies to the principles of lean manufacturing and gentle metallurgy;
– to differentiate the modern physico-chemical complex of methods for the analysis of metallurgical raw materials and products, to design powder materials;
– apply modern, advanced knowledge about innovative technologies for obtaining rare, rare-earth and precious metals, light and refractory metals using resource- and energy-saving techniques of technological schemes;
– to rationalize the use of critically important, strategic and man-made raw materials, and to manage metallurgical production waste;
– to prevent and predict structural corrosion problems in the metallurgical industry; to be aware of various types and types of equipment in the field of metallurgy in order to select the most optimal layout schemes and prevent structural problems.
– to program and develop "MES-systems" for collecting and storing data on technological processes in metallurgy.
– systematize the principles of building digital data processing tools, the use of microprocessors in control systems for technical facilities and technological processes, design control systems based on microcontrollers, and develop application software.
– perform an analysis of consumer properties of products made of energy-generating metals and apply statistical methods of quality management at manufacturing enterprises of the metallurgical industry.
have the skills:
- scientific research activities, solving standard scientific problems;
- implementation of educational and pedagogical activities on credit technology of education;
- methods of teaching professional disciplines;

- the use of modern information technologies in the educational process;
- 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.
– formation of a search for economically feasible technologies and methods to reduce emissions of harmful substances into the environment;
– identification and assessment of environmental risks in the conduct of economic activities in the metallurgical industry;
– monitoring of the environmental situation at deposits, processing plants and processing plants;
– determining the impact of technological processes on the ecosystem;
– application of methods to reduce gaseous emissions from metallurgical enterprises, selection of equipment;
– gentle metallurgy in the creation of environmentally friendly production, methods for reducing emissions and waste from metallurgy.

be competent:

– in research and innovation and design activities, - in technologies for obtaining energy-generating metals; – in the transformation of existing technologies in the field of non-ferrous metallurgy to the principles of gentle, environmentally friendly, integrated processing of raw materials in conditions of depletion of ores and waste, while simultaneously digitalizing production. – in adapting technological schemes to the depletion of ores,
– in greening metallurgical industries, efficient recycling of waste from the metallurgical sector,
– in increasing automation and robotization of production, increasing the degree of wear of equipment in the mining and metallurgical sector.
- 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.

B - Basic knowledge, skills and abilities

B1 - To know the history and philosophy of science, pedagogy and psychology of management, pedagogy of higher education;
B2 - The ability to independently apply methods and means of cognition, learning and self-control to acquire new knowledge and skills, including in new areas that are not directly related to the field of activity.
B3 - To be proficient in the state language, Russian and one of the most common foreign languages in the industry at a level that ensures human communication.

B4 - Be able to use fundamental general engineering knowledge, the ability to practically use the basics and methods of mathematics, physics and chemistry in their professional activities.
B5 - Proficiency in professional terminology and the ability to work with educational and scientific materials in the specialty in the original in a foreign language. Knowledge of communication and professional terminology.
B6 - General engineering skills, engineering calculations in metallurgy.
B7 - Possession of fundamental knowledge on the theory of mineral processing and metallurgical processes;
B8 - Basic knowledge of waste management, metal recycling.
B9 - planning experiments and processing experimental data
B12 - To know and master the basic business processes in an industrial enterprise, to implement the principles of gentle metallurgy and greening processes.

P - Professional competencies

P1 is able to evaluate the results of scientific and technical developments, scientific research and justify their own choice, systematizing and summarizing achievements in the metallurgy industry and related fields.;
P2 - Fundamental problems of non-ferrous metallurgy. Apply the basic principles of lean R&D and their use practices to measure the level of readiness of an innovative product/project for commercialization
P3 - Is able to develop proposals to improve the efficiency of the use of raw materials and energy resources in the production of non-ferrous, rare and precious metals;
P4 - Theoretical and technological foundations of processes and technologies for the production of non-ferrous metals and their compounds.
P5 is able to find and process information required for decision-making in scientific research and in practical technical activities, to carry out modeling, analysis and experiments in order to conduct detailed research to solve complex problems in the professional field.
P6 - Possess the skills to carry out technological, thermal and energy calculations
P7 - Databases, application software packages and computer graphics tools for solving professional tasks
P8 - Be able to calculate and select the main and auxiliary equipment
P9 - Is able to manage resources
P10 is able to apply professional knowledge to create flexible, multi-purpose and/or energy-saving progressive metallurgical processes and technologies for processing primary and/or secondary raw materials of non-ferrous, rare and precious metals.
P11 - Theoretical and technological foundations of progressive technologies and the latest ways to intensify metallurgical processes for the production of non-ferrous metals
P12 - Is able to carry out research and development work on the subject of the organization.
P13 - Be able to develop energy- and resource-saving technologies in the field of extractive metallurgy

P14 – be able to perform calculations of processes and devices of extractive metallurgy
P15 – apply the principles of gentle metallurgy,
P16 - Is able to develop scientific and technical, design and service documentation, prepare scientific and technical reports, reviews, publications, reviews, design and develop products, processes and systems in conditions of uncertainty and alternative solutions in interdisciplinary fields
P17 is capable of solving production and (or) research tasks based on fundamental knowledge, knowledge in interdisciplinary fields in the field of metallurgy.
P 18 is able to evaluate the results of scientific and technical developments, scientific research and justify its own choice, systematizing and summarizing achievements in the metallurgy industry and related fields.
P 19 - Apply the basic principles of lean R&D and the practice of using them to measure the level of readiness of an innovative product/project for commercialization
P 20 – Apply the skills of intellectual property protection and patenting
P 21 – Apply methods of gentle and lean metallurgy in the metallurgy of rare earth and radioactive metals, in the production of rare earth and radioactive metals.

O - Universal, socio-ethical competencies

O1 - is able to use English fluently as a means of business communication, a source of new knowledge in the field of automation or robotization of production processes. I am ready to use English in professional activities in the field of enrichment and metallurgy;
O2 is able to speak Kazakh (Russian) fluently as a means of business communication, a source of new knowledge in the field of automation or robotization of production processes. I am ready to use Kazakh (Russian) language in professional activities in the field of enrichment and metallurgy;
O3 - to know and apply the fundamentals of applied ethics and ethics of business communication in work and life;
O4 - know and apply the basic concepts of professional ethics;
O5 - to know and solve the problems of human influence on the environment.

C - Special and managerial competencies

C1 - independent management and control of the processes of labor and educational activities within the framework of the strategy, policy and goals of the organization, discussion of problems, reasoning conclusions and competent information management;
C2 - to be a specialist in conducting experimental studies of extractive metallurgy and recycling facilities;
C3 - to be a researcher, a specialist in scientific research of ore processing facilities, extractive metallurgy and recycling;

C4 - to be an engineer for the development and design of metallurgical production lines.
C 5 – to be able to find and process the information required for decision-making in scientific research and in practical technical activities, to carry out modeling, analysis and experiments in order to conduct detailed research to solve complex problems in the professional field.

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	7M07201-Automation and digitalization of metallurgical processes
5	Short description of educational program	The educational program 7M07201 - "Automation and digitalization of metallurgical processes" includes industry-specific, priority, fundamental, natural science, general engineering and professional training of masters in the field of automation and digitalization of metallurgical processes related to the implementation, operation and modernization of databases as the basis for product lifecycle management in relation to metallurgical processes.
6	Purpose of EP	The educational program consists in students mastering the scientific foundations of building, maintaining and operating automation systems for metallurgical processes; studying and mastering modern methodology, technology and tools related to the implementation, operation and modernization of databases as the basis for product lifecycle management in relation to metallurgical processes; possession of basic knowledge of sustainable technologies for processing mineral raw materials; training undergraduates basic and specialized disciplines with the achievement of relevant competencies.
7	Type of EP	Innovative
8	The level based on NQF	Level 7 – Postgraduate education. Master's degree (based on the mastered

		bachelor's degree program), practical experience.
9	The level based on IQF	Level 7 – Conceptual professional and/or scientific knowledge (including innovative) and experience in a particular field and/or at the junction of fields. Evaluation and selection of professional information. Creation of new applied knowledge in a certain field. Identification of sources and search for information necessary for the development of activities
10	Distinctive features of EP	The concept of the educational program differs in that the training is aimed at studying the transformation of existing technologies in the field of non-ferrous metallurgy to the principles of gentle, environmentally friendly, integrated processing of raw materials in conditions of depletion of ores and waste while simultaneously automating and digitalizing production.
11	List of competencies of educational program	*1) have an idea of:* – the role of science and education in public life; – about current trends in the development of scientific knowledge; – about the professional competence of a high school teacher. *2) know:* – the methodology of scientific knowledge; – principles and structure of scientific activity organization; – the 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; – research methods of processing and metallurgical processes, equipment operation. *3) be able to:* – develop energy- and resource-saving technologies in the field of mineral processing, metallurgy and metalworking; – develop environmental protection measures for enrichment and metallurgical production; –to plan experimental research, choose research methods. *4) have the skills:* – scientific research activities, solving standard scientific problems;

		– implementation of educational and pedagogical activities on credit technology of education; – methods of teaching professional disciplines; – the use of modern information technologies in the educational process; – professional communication and intercultural communication *5) be competent:* – in the field of scientific research methodology; – in the field of scientific and scientific-pedagogical activity 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 continuous updating of knowledge, expansion of professional skills and abilities.
12	Learning outcomes of educational program	LO1 Systematize data mining, apply descriptive, correlation and regression analyses, classical calculus of variations and matrix description of spatial mechanisms. LO2 Uses modern control theory: synthesis of systems with a given dynamics using standard and relay controllers, digital control systems, systems with a variable structure of modal control, identification and adaptation of optimal control. LO3 Integrate the psychological patterns of managerial activity, training, conducting research, carrying out scientific and methodological work LO4 Apply modern, advanced knowledge about innovative technologies of the metallurgical complex: critical technologies in metallurgy, technologies for processing uranium raw materials, resource and energy conservation in metallurgy (gentle metallurgy), wastewater treatment, nanostructured materials production, waste management, digital control systems in the metallurgical complex, development of measures aimed at improving the efficiency of technological processes LO5 Diagnose the reliability of automation systems, carry out

		installation, commissioning, automation and operation of production systems in the metallurgical sector, create automated process control systems and robotic technological complexes for sustainable pyro- and hydrometallurgical technologies. LO6 Demonstrate the skills of teaching and mentoring undergraduate students, teaching, conducting research, carrying out scientific and methodological work LO7 Solve engineering calculations in the field of pyro- and hydrometallurgical processes and apparatuses, calculate and predict heat and mass transfer processes, analyze thermal regimes, simulate heat exchange of metallurgical units using automation systems, develop measures aimed at improving the efficiency of technological processes LO8 To develop an experiment and analyze elements of automated process control systems. LO9 Differentiate methods and means of analysis of metallurgical processes and products, design powder and composite materials LO10 To investigate and make calculations using software on thermodynamics and kinetics of metallurgical processes, to justify the choice of processes and requirements for the hardware design of the technological process. LO11 To program and develop "MES-systems" for collecting and storing data on metallurgical technological processes. LO12 Synthesize skills in management psychology, critical thinking, leadership, understanding self-education, personal management, teamwork, teamwork, establish professional ethics and communication with partners LO13 Demonstrate communicative, professional and technical language knowledge in English, knowledge of philosophical concepts of natural science, scientific worldview.
13	Education form	Full - time full
14	Period of training	2 years
15	Amount of credits	120
16	Languages of instruction	Kazakh/Russian

17	Academic degree awarded	Master of Technical Sciences
18	Developer(s) and authors	Chepushtanova T.A. Sultanbayeva A.B.

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)												
				PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PO13
Cycle of basic disciplines University component																
LNG213	Foreign language (professional)	The course is aimed at studying the main problems of scientific knowledge in the context of its historical development and philosophical understanding, the evolution of scientific theories, principles and methods of scientific research in the historical construction of scientific paintings of the world. The discipline will help to master the skills of developing critical and constructive scientific thinking based on research on the history and philosophy of science. At the end of the course, undergraduates will learn to analyze the ideological and methodological problems of science and engineering and technical activities in building Kazakhstan's science and the prospects for its development.	3			v			v							v
HUM214	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 activity. Discipline will help you	3			v			v						v	

		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.														
HUM212	History and philosophy of science	Purpose: to explore the history and philosophy of science as a system of concepts of global and Kazakh science. Content: the subject of philosophy of science, dynamics of science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy of mathematics, physics, engineering and technology, specifics of engineering sciences, ethics of science, social and moral responsibility of a scientist and engineer.	3			v			v						v	v
HUM213	Higher school pedagogy	The course is aimed at mastering the methodological and theoretical foundations of higher education pedagogy. The discipline will help to master the skills of modern pedagogical	3						v						v	v

		technologies, technologies of pedagogical design, organization and control in higher education, skills of communicative competence. At the end of the course, undergraduates learn how to organize and conduct various forms of organizing training, apply active teaching methods, and select the content of training sessions. Organize the educational process on the basis of credit technology of education.														
Cycle of basic disciplines Component of choice																
MET765	Calculations of pyro- and hydrometallurgical processes and apparatuses	Acquisition of knowledge by master's on the basic calculations of pyrometallurgical processes, taking into account resource and energy saving, selection and calculation of the main and auxiliary equipment, taking into account the innovativeness of modern designs. Calculations of hydrometallurgical processes and apparatuses of the main modern technologies of leaching and extraction processes included in "gentle metallurgy".	5					**v**		**v**			**v**	**v**		
MET289	Theory and calculations of metallurgical thermodynamics and kinetics	Purpose: To study the theory and calculations of metallurgical thermodynamics and kinetics Content: The processes occurring in metallurgical systems are considered from the positions of thermodynamics and kinetics.	5				**v**			**v**			**v**			

		The characteristics of equilibrium and nonequilibrium processes and States of metallurgical systems are given. Theoretical positions and conclusions about the structure and properties of metal, oxide and sulfide systems. Basic calculations on thermodynamics and kinetics of metallurgical processes. Calculation of thermodynamic and kinetic parameters using modern digital programs (software) for calculations.														
MNG782	Sustainable development strategies	Purpose: To train graduate students in sustainable development strategies to achieve a balance between economic growth, social responsibility, and environmental protection. Content: Graduate students will study the concepts and principles of sustainable development, the development and implementation of sustainable development strategies, the evaluation of their effectiveness, and international standards and best practices. Cases and examples of successful sustainable development strategies are included.	5			v					v					v
MET290	Special chapters of heat exchange of metallurgical processes	The aims and objectives of the course is the acquisition of knowledge and skills by	5					v		v			v			

		undergraduates on the main processes of heat transfer of metallurgical processes, types of heat transfer. Study of the process of thermal conductivity, the influence of various factors on the coefficient of thermal conductivity. Calculations of stationary problems on thermal conductivity through a single-layer, flat, cylindrical and spherical wall. Study of the main processes in convective heat flow. The study of heat transfer through the process of radiation. Performing calculations for complex heat transfer. Methods for solving problems of non-stationary heat conduction. Theory of heating thin and massive bodies.															
MEI230	Methodology of scientific research	The purpose of the course: the formation of a system of ideological ideas about methodology as a branch of intellectual activity, one of the functions of which is the implementation of mutually enriching links between disciplines of various levels of generalization; the study of methodological principles and approaches to scientific research; the formation of methodological and scientific culture, flexible perception of scientific texts. The subject and basic concepts of	5				**v**								**v**		

		modern methodology of science. Scientometrics and the use of the main publication databases (SCOPUS, WoS).														
AUT264	MES systems	The course "MES systems" deals with data collection and storage, interaction of information subsystems in order to obtain, accumulate and transfer technological and control data circulating in the production environment of the enterprise; product quality management, analysis of product quality measurement data; production process management, monitoring of production processes, automatic correction or dialog support of operator decisions, maintenance and repair management.	5	v	v			v			v			v		
AUT205	Diagnostics and reliability 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.	5		v			v						v		

MNG781	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.	5			v					v					v
Cycle of profile disciplines University component and Component of choice																
AUT700	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 concepts in the theory of reliability, quantitative indicators of the reliability of renewable and non-renewable technical systems, the main methods for calculating the reliability of complex systems, types of tests for reliability, backup issues and determining the reliability of backup systems. To consolidate the theoretical materials, standard tasks are presented. As well as issues of reliability of automation and control systems.	5	v	v			v								
AUT237	Digital control systems	The content of the discipline "Digital Control Systems" includes the study of the mathematical apparatus for describing digital systems,	5	v	v						v			v		v

		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.														
MET293	Stable pyro - and hydrometallurgical technologies of processing of mineral raw materials	The aims and objectives of the course are to acquire knowledge and skills for undergraduates in sustainable pyrometallurgical technologies for processing mineral raw materials: the study of energy saving in pyro-processes: flash smelting for matte production, matte refining processes and converting to obtain blister copper, metallothermic processes. Study of sustainable hydrometallurgical technologies for the processing of mineral raw materials: the influence of diffusion propagation on the dissolution potential in mineral raw material leaching systems; underground leaching of rare earth elements, biohydrometallurgy technologies	5					v		v				v		
MET766	Resource and energy saving in metallurgy (gentle metallurgy)	Acquiring knowledge by master's on new schemes for obtaining metal, based on saving resources and preserving the environment, on modernizing the equipment of enterprises that ensure the preservation of the priorities of	5				v	v				v				

		ecology and resource saving in metallurgy, lean production, familiarity with a wide cross-functional base about various types and types of equipment in the field of metallurgy for selection the most optimal schemes for their layout.														
MET298	Methods and means of analysis of metallurgical processes and metallurgical products	The course provides basic information about the current state and development of methods for analyzing MT. Methods for measuring electrical conductivity; methods for studying the equilibrium of chemical reactions in metallurgical systems. Along with the theoretical foundations of analysis methods, a description is given of installations and instruments used for research in laboratory and production conditions.	5				**v**	**v**				**v**		**v**		
MET297	Theory and technology of nanostructured materials	The aims and objectives of the course are to acquire undergraduate knowledge on the basics of nanotechnology in metallurgy and classify processes, to study the types of nanomaterials: consolidated nanomaterials, nanosemiconductors, nanopolymers, nanobiomaterials, fullerenes and tubular nanostructures, catalysts, nanoporous materials and supramolecular structures. Study	5				**v**			**v**				**v**		

		of technologies for obtaining nanoparticles (nanopowders), determination of the properties of nanopowders, determination of the use of nanopowders in industries. Natural boundaries of the development of existing microelectronics.														
MET291	Waste management of metallurgical industry	The aims and objectives of the course is to acquire undergraduate knowledge on the basics of waste management in the metallurgical industry, to study the classification of metallurgical waste. Studying the safe disposal and disposal of waste, determining the disposal of waste without causing harm to public health and damage to the environment. Waste disposal at the expense of the manufacturer. Physico-chemical, technological and environmental aspects of processing the most typical types of waste from the metallurgical industry. Selection and justification of technological schemes for the processing of metal-containing waste.	5				**v**					**v**		**v**		
MET292	Treatment of waste water of metallurgical enterprises	The course includes methods of wastewater treatment, the concept of environmental safety of the metallurgical industry. The problem of wastewater formation. The mechanical method and the reagent for chemical cleaning of industrial	5				**v**					**v**		**v**		

		wastewater treatment. Nonchemical methods: electrochemical, electronicaly, the use of ion exchange resins, ozonation. Methods of mechanical cleaning. Device for mechanical treatment: grates, drum grid, sedimentation basins, filters, sologirlsmasturbating etc.														
AUT705	Optimal control systems (with AI elements)	The content of the discipline "Optimal control systems" includes the study of mathematical methods of optimal control based on classical calculus of variations, the basics of the maximum principle and the method of dynamic programming. Models and methods of program and stabilizing optimal control are considered. Methods of synthesis of intelligent optimal control systems are considered separately.	5	v	v			v								
AUT707	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.	5	v				v						v		

		The maximum benefits of a distributed system are achieved when controllers work autonomously, and the exchange of information between them is minimized.														
AUT285	Modern executive devices of automation systems	The course content discusses general issues of the theory of automation actuators, outlines the principles of classification 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 installation devices in automation systems	5		v			v				v				
AUT701	Automation of control systems design	The content of the discipline "Automation of control systemы design" includes the study of methods of analysis and synthesis of control systems, the choice of structure and the calculation of parameters of the control law. The procedures of analytical design of regulators, development of structural, functional and other automation schemes with the use of modern application software packages are considered.	5	v			v	v			v		v			
MEI242	The electrolysis of aqueous and non-aqueous media	Purpose: Formation of knowledge on the basics of electrometallurgical and electrochemical processes and the skills of their application in	5				v			v		v				

		metallurgy. Contents: Electrolysis of aqueous and non-aqueous media" examines the laws, theoretical provisions and examples of the practical application of electrolysis in metallurgical practice. Systematic ideas about the theoretical foundations and methods of modern electrochemical methods for extracting metals from aqueous solutions and salt melts are being formed.														
MET767	Construction of powder and composite materials	The aims and objectives of the course are to acquire undergraduate knowledge on the rational design of powder and composite materials, on the development of technical solutions for the manufacture of parts and assemblies, taking into account new production challenges that can ensure the maintenance of outdated equipment in production. Development of materials with targeted physical and chemical properties for the tasks of the enterprise, development of new powder and composite materials with the required physical and technical properties.	5				**v**	**v**				**v**		**v**		
AUT286	Microprocessor control systems of technological processes	The use of microprocessors in the management of distributed systems as a means of collecting and primary processing,	5				**v**	**v**			**v**				**v**	

		transmission, transformation, as well as controllers of technological processes has expanded the functionality of sensors, actuators, peripheral and terminal devices. This course discusses the issues, the study of which will give undergraduates the basic knowledge and skills necessary to solve industrial and scientific problems related to the choice of microprocessor control systems.														
MEI223	Modern technologies of rare, rare earth and precious metals	Modern technologies of rare metals: industrial schemes for the production of tungsten, molybdenum, rhenium; development of new and improvement of existing technologies; industrial schemes for the production of titanium, tantalum, niobium, zirconium, hafnium. Industrial schemes for the production of rare earth metals (REM). Strategy for finding new and improving existing technologies. Industrial schemes for the production of noble metals. Analysis of the process/technology for the production of precious metals. Selection and justification of the direction of process/technology improvement.	5				**v**			**v**			**v**		**v**	

5. Curriculum of educational program

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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board-
Rector of Kazntu named after K.Satpayev
M.K.M. Begentaev
«___» _____ 2024 y.

CURRICULUM
of Educational Program on enrollment for 2024-2025 academic year

Educational program 7M07201 - "Automation and digitalization of metallurgical processes"
Group of educational programs M117 - "Metallurgical engineering"

Form of study: full-time | Duration of study: 2 year (autumn) | 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	4 semester
CYCLE OF BASIC DISCIPLINES (BD)											
M-1. Module of basic training (university component)											
LNG213	English (professional)	BD UC	3	90	0/0/2	60	E	3			
HUM214	Management Psychology	BD UC	3	90	1/0/1	60	E	3			
HUM212	History and philosophy of science	BD UC	3	90	1/0/1	60	E		3		
HUM213	Higher school pedagogy	BD UC	3	90	1/0/1	60	E		3		
component of choice											
MET765	Calculations of pyro- and hydrometallurgical processes and	BD CCH	5	150	2/0/1	105	E	5			
MET289	Theory and calculations of metallurgical thermodynamics and kinetics				2/0/1	105					
MNG782	Sustainable development strategies										
MET290	Special chapters of heat exchange of metallurgical processes	BD CCH	5	150	2//1/0	105	E	5			
MET230	Technologies for processing uranium-containing raw materials				2/0/1	105					
AUT264	MES systems	BD CCH	5	150	2/0/1	105	E			5	
AUT205	Diagnostics and reliability of automation systems										
MNG781	Intellectual property and research										
CYCLE OF PROFILE DISCIPLINES (PD)											
M-2. Module of professional activity (university component, component of choice)											
AUT700	The reliability of the management system and its elements	PD US	5	150	2/0/1	105	E	5			
AUT237	Digital control systems	PD US	5	150	2/0/1	105	E	5			
MET293	Stable pyro - and hydrometallurgical technologies of processing of mineral raw materials	PD US	5	150	2/0/1	105	E		5		
MET766	Resource and energy saving in metallurgy (gentle metallurgy)	PD US	5	150	2/0/1	105	E		5		
MET298	Methods and means of analysis of metallurgical processes and metallurgical products	PD CC	5	150	2/1//0	105	E			5	
MET297	Theory and technology of nanostructured materials				2//1/0	105					
MET291	Waste management of metallurgical	PD CC	5	150	2/0/1	105	E		5		
MET292	Treatment of waste water of metallurgical enterprises				2/0/1	105					
AUT705	Optimal control systems (with AI elements)	PD CC	5	150	2/0/1	105	E		5		
AUT707	Distributed Control Systems				2/0/1	105					
AUT285	Modern executive devices of automation systems	PD CC	5	150	1//1/1	90	E			5	
AUT701	Automation of control systems design				2/0/1	105					
MEI242	The electrolysis of aqueous and non-aqueous media	PD CC	5	150	2//1/0	105	E			5	
MET767	Construction of powder and composite materials				2/0/1	105					

AUT286	Microprocessor control systems for technological processes	PD CC	4	120	1//1/0	75	E				4
MEI223	Modern technologies of rare, rare earth and precious metals				2/0/1						
M-3. Practice-oriented module											
AAP273	Pedagogical practice	BD UC	8							8	
AAP256	Research practice	PD, CCH	4								4
M-4. Experimental researeh module											
AAP268	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	4					4			
AAP268	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	4						4		
AAP251	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	2							2	
AAP255	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	14								14
M-5. Module of final attestation											
ECA212	Preparation and defense of a master's thesis	FA	8								8
	Total based on UNIVERSITY:							30	30	30	30
								60		60	

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
			university component (UC)	component of choice (CCH)	Total
BD	Cycle of basic disciplines		20	15	35
PD	Cycle of profile disciplines				53
	Total for theoretical training:	*0*	*20*	*15*	*88*
	RWMS				*24*
FA	Final attestation	12			8
	TOTAL:	12	20	15	120

Decision of the Academic Council of Kazntu named after K.Satpayev. Protocol № 12 "22" 04 2024 y.

Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № 6 "10" 04 2024 y.

Decision of the Academic Council of the Institute MMT. Protocol № 7 от "27" 03 2024 y.

Board Member -Vice-Rector for Academic Affairs — **Uskenbayeva R.K.**

MandMI Director — **Rysbekov K.B.**

Department Head MP,HEandTSM — **Chepushtanova T.A.**

Department Head AandC — **Aldiyarov N.U.**

The representative of the Specialty Council from the employers of Kazakhmys LLP — **Ospanov.E.A.**