



**Mining and Metallurgical Institute named after O.A. Baikonurov
Department «Metallurgy and mineral processing»**

TWO-DEGREE EDUCATIONAL PROGRAM

7M07204 – Metallurgy and mineral processing

Code and classification of the field of education:	7M07 – Engineering, manufacturing and construction industries
Code and classification of areas of study:	7M072 – Manufacturing and manufacturing industries
Group of educational programs:	M117 – Metallurgical engineering
NQF level:	7
ORC level:	7
Training period:	2 years
Volume of loans:	120

Almaty 2025

The two – degree educational program «7M07204 - Metallurgy and mineral processing» was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

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

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The two – degree educational program «7M07204 – Metallurgy and mineral processing» was developed by Academic committee based on direction of «7M072 – Manufacturing and processing industries»

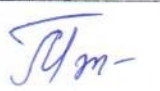
Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairperson of Academic Committee:				
Barmenshinova M.B.	c.t.s., associate professor	Head of the Department of MaMP	KazNRTU named after K.I.Satpaeva	
Teaching staff:				
Moldabayeva G.Zh.	c.t.s., associate professor	Professor of the Department of MaMP	KazNRTU named after K.I.Satpaeva	
Ussoltseva G.A.	c.t.s.	Associate professor of the Department of MaMP	KazNRTU named after K.I.Satpaeva	
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» LPP	

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List of abbreviations and symbols

NJSC "Kazakh National Research Technical University named after K.I. Satpayev" - NJSC KazNRTU named after K.I. Satpayev;

SOSE - State obligatory standard of education of the Republic of Kazakhstan;

MSaHE RK - Ministry of Science and Higher Education of the Republic of Kazakhstan;

EP - educational program;

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

IWST - 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;

SQF - Sectoral Qualifications Framework;

LO - learning outcomes;

KC - key competencies;

SDG—Sustainable Development Goals.

1. Description of the educational program

Introduction to the educational program. The development of an innovative economy initially forms the so-called double helixes of interaction - between universities (science) and business, business and government, etc., which then form a "triple helix". The triple helix model generates interdisciplinary knowledge generated by interdisciplinary teams brought together for a short time to work on a specific real-world problem. In the triple helix model, universities, along with the educational and research function, further increase entrepreneurial functions, actively participating in the cultivation of start-ups together with industry, stimulated by the state.

The concept of this scientific and educational program is based on the triple helix model, which involves the creation of innovative solutions based on interdisciplinary research and educational programs (Figure 1).



Figure 1 - The concept of scientific and educational programs

The previously established structure of education, based on the deep training of specialists in a narrowly focused specialization, has led to the emergence of interdisciplinary barriers and curbing the development of new "growth points" that are at the intersection of disciplines.

Modern needs require graduates not only to have deep knowledge in their chosen field of science, but also to understand the mechanisms and tools for putting their ideas into practice.

The program corresponds to the unified state policy of long-term socio-economic development of the country, the training of highly qualified personnel based on the achievements of science and technology, the effective use of the domestic scientific, technological and personnel potential of the republic.

The program is complex and science intensive. The efficiency of using its results is of strategic importance for the republic.

The program is aimed at training specialists in key areas of the mining and metallurgical industry, adapted to work in high-tech sectors of the economy of the Republic of Kazakhstan based on the development of priority areas of science and

technology, the development of high-tech industries, competitive technologies in the field of processing man-made raw materials and waste.

The developed Program is the basis of a harmonious and flexible system for training advanced scientific and innovative personnel, combining deep fundamental knowledge with a broad scientific outlook and the ability to independently conduct research work with a comprehensive understanding of the main problems in the mining and metallurgical industry.

The term of study in the magistracy is determined by the amount of mastered academic credits. Upon mastering the established amount of academic credits and achieving the expected learning outcomes for obtaining a master's degree, the master's educational program is considered to be fully mastered. The scientific and pedagogical magistracy provides 120 academic credits for the entire period of study, including all types of educational and scientific activities of the undergraduate.

Planning the content of education, the method 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 program in the scientific and pedagogical direction implements educational programs of postgraduate education 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 educational program of the master's program consists of:

- 1) theoretical education, including the study of cycles of basic and major 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 a scientific and pedagogical magistracy
- 4) final certification.

The educational program includes the following stages of undergraduate training: English (professional), psychology of management, history and philosophy of science, pedagogy of higher education, engineering calculations in metallurgy, theory and calculations of metallurgical thermodynamics and kinetics, technologies and processes of rectification and condensation in metallurgy, technology and refining of radioactive metals, modern and promising technologies for processing ore and technogenic raw materials, technology and refining of noble metals, theory of processes of metallurgical engineering, modern and promising technologies for processing raw materials of ferrous and non-ferrous metallurgy, special methods of hydrometallurgy, technology for the isolation and utilization of toxic elements from metallurgical raw materials, technologies for processing uranium-containing raw materials, technologies for extracting metals from slags, chlorine and vacuum technologies in metallurgy, project management, recycling technologies in ferrous and non-ferrous metallurgy, mass transfer in heterophase metallurgical systems, processes and production of ultra-pure metals, special chapters in extractive metallurgy (in English), technology of fractional separation

of metals from a vapor-gas mixture, plasma metallurgy.

Possibility to choose disciplines from the catalog of elective disciplines of Satbayev University.

Types of professional activity

Graduates of the educational program of the scientific and pedagogical master's program "Metallurgy and mineral processing" can perform the following types of professional activities: design, production and technology, organizational and managerial, research and teaching.

A distinctive feature of the master's program is that the educational program provides knowledge, skills and abilities in the use of "green" technologies and materials, the production and sale of metallurgical products; on the development of regulatory and technical documentation for the metallurgical sector; for the improvement and preparation of means of metallurgical production. Graduates receive knowledge in the field of development and implementation of metallurgical technologies, production of innovative metallurgical products, enhanced consumer properties; graduates have high leadership and organizational qualities; capable of creating small science-intensive metallurgical businesses.

The mission of the educational program of the master's program "Metallurgy and mineral processing" is the formation of students' social and personal qualities and professional competencies that allow graduates to successfully solve production, technological, organizational and managerial, design tasks in the field of metallurgy, and contribute to their sustainable demand in the labor market, as well as compliance with international education standards; providing enterprises with highly qualified specialists in the field of metallurgy, specializing in the implementation of promising fundamental, innovative, digital and applied research and the development and implementation of modern technological processes that provide high quality products at minimal cost.

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

Types and objects of professional activity.

The subjects of professional activity are the technological processes of the metallurgical industry, the production of metal products with increased consumer properties, the technology for obtaining and processing metals and materials, the study of the structure and properties, automatic control systems for metallurgical production and quality control of the final product.

2. Purpose and objectives of the educational program

The purpose of EP «7M07204 - Metallurgy and mineral processing» is:

– formation of personnel for an innovative economy in metallurgy and mineral processing, covering modern energy-saving technologies, design activities, innovative solutions, entrepreneurship in the high-tech field of mineral processing in accordance with the principles of sustainable development.

The tasks of the EP «7M07204 - Metallurgy and mineral processing» are:

- Competence of graduates in design and technological work in the implementation of projects to improve and optimize enrichment and metallurgical processes, increase their productivity and improve the quality of products.

– competence of graduates in the implementation of the development and implementation of technological processes for the processing of mineral, natural and technogenic raw materials;

- the competence of graduates in the implementation of the assessment of innovation and technological risks in the implementation of new technologies;

– competence of graduates in the system of digitalization of the mineral processing and metallurgy industries. Acquisition of competencies in production management at all stages of the life cycle of manufactured products;

– competence in the implementation of marketing of high technologies;

– study of modern technologies for reducing gas emissions and developing energy-efficient metallurgical processes;

– training of specialists capable of research and innovation activities at the international level.

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

A graduate of the scientific and pedagogical magistracy, must:
have an idea:

- on 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;
- about the professional competence of a high 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 mineral processing and metallurgy;
- 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.

to know:

- methodology of scientific knowledge;
- principles and structure of the organization of scientific activity;
- psychology of cognitive activity of students in the learning process;
- psychological methods and means of improving the effectiveness and quality of training;
- international and domestic standards, resolutions, orders, orders of higher and other domestic organizations, methodological normative and guidance materials related to the work performed;
- current state and prospects of technical and technological development of processing and metallurgical processes, features of the activities of institutions, organizations, enterprises and related industries;
- 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 of research of processing and metallurgical processes, equipment operation;
- basic requirements for technical documentation of materials and products;
- rules and norms of labor protection, issues of environmental safety of technological processes;
- methods of 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 conducting scientific research and practical activities;
- the methodology of conducting all types of training sessions and independent work of students.

be able to:

- to develop technological processes for obtaining conditioned concentrates from ore, as well as metals from concentrates, processing of metals and alloys, schemes of processing and metallurgical processes, to justify operating parameters and indicators;
- to draw up a business plan for a technological project;
- develop energy- and resource-saving technologies in the field of mineral processing, metallurgy and metalworking;
- develop environmental protection measures for enrichment and metallurgical production;
- carry out planning of experimental studies, choose research methods;
- to develop the scheme and design of the experimental installation, to carry out installation and debugging;
- process data using planning techniques, regression and correlation analysis, digitalization methods;
- to carry out measures for the organization of production in accordance with regulatory documents;
- 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 in different disciplines to solve research problems in new unfamiliar conditions;
- by integrating knowledge to make judgments and make decisions based on incomplete or limited information;
- apply the knowledge of pedagogy and psychology of higher education in their teaching activities;
- apply interactive teaching methods;
- to carry out information-analytical and information-bibliographic work with the involvement of modern information technologies;
- to think creatively and creatively approach the solution of new problems and situations;
- be fluent in a foreign language at a professional level, which allows conducting scientific research and teaching special disciplines in universities;
- to summarize the results of research and analytical work in the form of a dissertation, scientific article, report, analytical note, etc.;

have skills:

- research activities, solutions of standard scientific tasks;
- implementation of educational and pedagogical activities on credit technology of training;
- methods of teaching professional disciplines;

- the use of modern information technologies in the educational process;
- professional communication and intercultural communication;
- oratory, correct and logical formalization of their thoughts in oral and written form;
- expanding and deepening the knowledge necessary for daily professional activities and continuing education in doctoral studies.

be competent:

- in the field of research methodology;
- in the field of scientific and scientific-pedagogical activity in higher educational institutions;
- in matters of modern educational technologies;
- in the implementation of scientific projects and research in the professional field;
- in ways to ensure constant updating of knowledge, expansion of professional skills and abilities.

B - Basic knowledge, skills and abilities

- B1 - Know the history and philosophy of science, pedagogy and psychology;
- 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 speak the state, Russian and one of the most common foreign languages in the industry at the level that provides 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. The ability to logically correctly, argumentatively and clearly build oral and written speech.
- B6 - General engineering skills.
- B7 - Possession of fundamental knowledge on the theory of mineral processing and metallurgical processes;
- B8 - Basic knowledge of waste management, metal recycling.
- B9 - Possession of modern and promising technologies of metallurgical production.
- B10 - To know and own the main business processes in an industrial enterprise.
- B11 - The ability to conduct pedagogical work using modern techniques and technologies.

P - Professional competencies

- P1 - a wide range of theoretical and practical knowledge in the professional field;
- P2 - is able to analyze technological lines of mineral processing and metallurgical processes.
- P3 - ready to install, adjust and operate production systems for mineral processing and metallurgical processes;

P4 - ready to participate in the development and design of new technologies and production lines for mineral processing, production of finished metal-containing products.

P5 - Have the skills of drawing up an equipment and technological scheme

P6 - Possess the skills to carry out technological, thermal and energy calculations

P7 - Be able to calculate aero- and hydrodynamics according to the circuit diagram of the apparatus

P8 - Be able to calculate and select the main and auxiliary equipment

P9 - Be able to develop and select drawings of equipment, buildings and structures

P10 - Be able to develop technological processes for the production and processing of metals and alloys

P11 - Be able to develop a scheme of enrichment and metallurgical processes, justify the operating parameters and indicators

P12 - Be able to draw up a business plan for a technological project

P13 - Be able to develop energy- and resource-saving technologies in the field of metallurgy and metalworking

P14 - Be able to develop environmental protection measures for metallurgical production

P15 - Be able to conduct a literary search, compile reports, reviews, conclusions, etc., choose research methods, plan and conduct necessary experiments, analyze and summarize research results, issue patents

P16 - Mastering the technology of processing slags and industrial products of non-ferrous and ferrous metallurgy for additional extraction of valuable components and solving environmental problems of the industrial region

P17 - The ability to use the knowledge, skills, and skills acquired in the course of training to develop a methodology for conducting research related to the professional field and to organize experiments with the analysis of their results

P18 - To identify issues related to the modernization and introduction of new technologies and equipment for the intensification of enrichment and metallurgical processes in order to increase the extraction contained therein valuable components

P19 - Possess practical skills in the field of independent organization and management of research works on the topic

P20 - The ability to apply the knowledge, skills, and skills acquired in the process of studying under the Master's degree program.

O - Universal, social and 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 my 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 my professional activity in the field of enrichment and metallurgy;

O3 - to know and apply in work and life the basics of applied ethics and ethics of business communication;

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 ore processing facilities and metallurgy;

C3 - to be a researcher, a specialist in scientific research of ore processing facilities and objects of finished metal-containing products;

C4 - to be an engineer for the development and design of processing and metallurgical workshops, factories, production lines.

4. Passport of the educational program

4.1. Field name

№	Field name	Note
1	Code and classification of the field of education	7M07 - Engineering, manufacturing and construction industries
2	Code and classification of areas of study	7M072 - Manufacturing and processing industries
3	Group of educational programs	M117 – Metallurgical engineering
4	Name of the educational program	7M07204 – Metallurgy and mineral processing
5	Brief description of the educational program	The educational program "Metallurgy and mineral processing" includes fundamental, natural science, general engineering and professional training of masters in the field of metallurgy in accordance with the development of science and technology, as well as the changing needs of the mining and metallurgical industry.
6	Purpose of the EP	formation of personnel for the innovative economy in metallurgy and mineral processing, covering modern energy-saving technologies, design activities, innovative solutions, entrepreneurship in the high-tech field of mineral processing in accordance with the principles of sustainable development
7	EP type	New
8	NQF level	7
9	ORC level	7
10	Distinctive features of the EP	Two-degree educational program
11	List of competencies of the educational program:	Professional competencies; Research competencies; Basic competencies and knowledge; Communication competencies; Universal competencies; Management competencies; Cognitive competencies; Creative competencies; Information and communication competencies.
12	Learning outcomes of the educational program:	LO1 - have fundamental scientific and professional training, have knowledge of modern social and political problems, speak state and foreign languages, tools of the market economy. LO2 - to know the organizational forms and principles of the learning process and pedagogical control, to apply the knowledge of pedagogy and psychology of higher education, management psychology in professional, scientific and pedagogical activities. LO3 - possess modern information technologies, including methods of obtaining, processing and storing scientific information, apply interactive teaching methods. LO4 - identify the most relevant research areas in metallurgy, be able to analyze and monitor modern problems of production, as well as to make management decisions based on their results, to develop energy- and resource-saving technologies in the field of metallurgy according to the best practices and standards of the industry. LO5 - to have the skills and abilities to work on modern scientific equipment, auxiliary equipment and instrumentation, to develop the scheme and design of an experimental installation, to carry out its

		installation and debugging. LO6 - conduct experimental studies of processes, aggregates and products, process data using planning techniques, regression and correlation analysis, develop mathematical and simulation models of metallurgy processes. Possess advanced metallurgical production technologies, including digital and automated control systems. LO7 - to know the regulatory and technological documentation of production, the requirements of standards, safety and environmental protection, to carry out measures to protect the environment in production. Know international environmental standards and regulations aimed at reducing the carbon footprint. LO8 - demonstrate methods of scientific work, professionally participate in scientific discussions, summarize the results of research and analytical work in the form of a dissertation, scientific article, patents, report, analytical note and other materials. LO9 - to have professional knowledge in the field of metallurgical disciplines that contribute to the formation of a highly educated person with a broad outlook and culture; to be able to combine theory and practice to successfully solve problems in the field of non-ferrous and ferrous metallurgy.
13	Form of study	full-time
14	Training period	2 years
15	Volume of loans	120
16	Languages of instruction	Kazakh, russian, english
17	Awarded Academic Degree	master of technical sciences
18	Developers and authors:	Barmenshinova M.B. Chepushtanova T.A.

4.2. Relationship between the attainability of the formed learning outcomes in 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
Cycle of basic disciplines												
University component												
1	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						
2	Psychology of management	The course is aimed at mastering the tools for effective employee management, based on knowledge of the psychological mechanisms of the manager's activity. Discipline will help you master the skills of making decisions, creating a favorable psychological climate, motivating employees, setting goals, building a team and communicating with employees. At the end of the course, undergraduates will learn how to resolve managerial conflicts, create their own image, analyze situations in the field of managerial activity, as well as negotiate, be stress-resistant and effective leaders.	3	V	V	V						
3	History and philosophy of science	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 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	3	V	V	V						

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		education.										
4	Higher school pedagogy	As part of the course, undergraduates will master the methodological and theoretical foundations of higher school pedagogy, learn how to use modern pedagogical technologies, plan and organize learning and education processes, master the communicative technologies of subject-subject interaction between a teacher and a graduate student in the educational process of a university. Also, undergraduates will study human resource management in educational organizations (using the example of a higher school).	3	V	V	V						
Cycle of basic disciplines Component of choice												
5	Engineering calculations in metallurgy	Purpose: Study of engineering calculations in metallurgy. Content: The discipline studies methods of thermodynamic, mass-exchange and technological calculations in the production of non-ferrous metals, including: the selection of process flow diagrams and the main metallurgical units; compilation of material and thermal balances; construction of balance charts; construction of graphs of dependencies and diagrams. Examples of drawing up algorithms of engineering calculations in metallurgy, drawing up flowcharts and programs using Excel and object-oriented programming languages are considered. Algorithms and programs for planning experiments and processing experimental data are studied.	5				V	V	V			
6	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. 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.	5				V	V	V			
7	Technologies and processes of distillation and condensation in metallurgy	Purpose: Familiarization with modern methods of rectification and condensation of metals, acquiring skills to solve specific problems on the technology of rectification	5				V	V		V		

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		and condensation of metals with a broad application of the fundamentals of physical chemistry and pyrometallurgical processes. Content: Formation of skills of application of rectification and condensation methods in metallurgy. Basic laws of evaporation and sublimation. Theory of condensation processes, peculiarities of condensation of vapor-gas mixture. The process of rectification, the scheme of the device rectification column. Calculation of rectification column. The role of external pressure in the processes of vaporization and condensation. Technology of rectification and condensation of zinc, titanium tetrachloride. Technology of distillation and rectification of selenium and tellurium. Improvement of designs of dust collectors and condensation apparatuses for rectification and condensation processes in non-ferrous metallurgy.										
8	Technology and refining of radioactive metals	Course Objective: To develop knowledge of theoretical patterns and practice of refining methods in the production of radioactive metals. Content: The course provides theoretical regularities and practice of the main processes of refining of radioactive metals (uranium, thorium and plutonium). Precipitation and extraction methods of purification in uranium technology; refining of uranium oxide from "yellowcake" and commercial desorbates; Technology and apparatus design of purification of thorium compounds (method of fractional neutralization, method of precipitation of hydrated thorium sulfate, methods of oxalate and extraction purification); and methods of separation of thorium and uranium. Technology and apparatus design of plutonium refining: precipitation and "dry" schemes of uranium and plutonium separation, extraction schemes with organic solvents.	5				V	V		V		
9	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	
10	Current and future technology for the processing of ore and technogenic raw materials	Purpose: Study of modern and promising methods of extraction and processing of ferrous, non-ferrous, rare and noble metals through their selective dissolution by chemical	5					V		V	V	

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		reagents in situ and subsequent extraction. Content: Ecologically safe processes of complex processing and stripping of hard-to-enrich ores and technogenic deposits on the basis of combining modern methods of enrichment, pyro- and hydrometallurgy with the use of additional energy impacts will be studied. Characteristics of the raw material base of metallurgy, features of the material composition of metal ores, description of technological schemes and modes are considered.										
11	Technology and refining of precious metals	Purpose: Formation of knowledge about the theoretical laws and practice of refining methods in the production of noble metals. Content: Refining of gold and silver. Raw materials and their preparation for refining, chlorine process, refining by electrolysis, acid refining methods. Losses and carry-over of gold and silver in the refining of noble metals. Removal of gold and silver with waste gases, irretrievable losses of noble metals during refining, treatment of production waste. Refining of PGM (platinum group metals). Raw materials for obtaining platinum metals, processing of schlich platinum: dissolution and finishing of solutions, treatment of mother liquors. Production of rhodium and iridium. Production of osmium and ruthenium. Processing of waste refining of platinum slimes.	5				V	V		V		
12	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		
Cycle of profile disciplines University component												
13	Theory of metallurgical engineering processes	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	5				V	V	V			V

		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										
14	Current and future technologies for processing raw materials of ferrous and nonferrous metallurgy	Purpose: Studying methods of extraction and processing of ferrous, non-ferrous, rare and noble metals by means of their selective dissolution by chemical reagents at the site of occurrence and subsequent extraction of chemical compounds formed in the reaction zone. Content: The characteristics of the raw material base of ferrous and non-ferrous metallurgy are considered, the features of the material composition of ores of ferrous and non-ferrous metals are considered, the technological schemes and modes are described, the issues of preparation of ores for enrichment starting from the early stages of mining production are disclosed, the optimal conditions of pre-concentration of ores are indicated, providing the increase of the complexity of the use of raw materials in the process of mining production and enrichment. In addition, the principles of production organization and prospects for the development of equipment and technology of enrichment of ores of ferrous and non-ferrous metals are outlined.	5					V		V	V	
15	Special methods of hydrometallurgy	Purpose: Acquisition of knowledge and skills in the field of technology of processing of ore and man-made raw materials by solutions of alkaline reagents and ammonia. Content: Thermodynamic probability of reactions of leaching of mineral raw materials by alkaline reagents. Kinetics of the leaching process. State of metals in solutions of hydroxyl reagents. Technological features of alumina production by hydroalkali method. Organization of associated extraction of vanadium and gallium in the processing of alumina-containing raw materials. Ammonia hydrometallurgy. Complexation equilibria in ammonia-water solutions. Physicochemical prerequisites for the use of mixed solutions of sodium hydroxide and ammonia as leaching reagents. Apparatus design of leaching processes.	5				V	V	V			V

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		Examples of industrial use of hydroalkali processing of mineral and technogenic raw materials. Some technological aspects and prospects for the development of ammonia hydrometallurgy.										
16	The technology of selection and disposal of toxic elements from the metallurgical raw materials	Purpose: To study the technology of extraction and utilization of toxic elements from metallurgical raw materials Content: Master's Courses. Characteristics of secondary technogenic raw materials and recycled in the metallurgy. Technology of utilization of sulfur dioxide in the industrial production of nonferrous metals from sulfide material. Utilization and disposal of gases containing fluorine, chlorine and other harmful substances. Technology selection and utilization of antimony and arsenic from flue gas processing antimony sulfide-arsenic concentrates. Technology of extraction of fluorine from waste aluminum production. Cleaning and utilization of industrial waste non-ferrous metals. Characteristics of technogenic raw materials and recycled in the metallurgy. Selection of reagents for the recultivation of contaminated land.	5					V		V	V	
17	Special chapters of extractive metallurgy (in English)	Purpose of the course: Formation of undergraduates' systematic knowledge about the basics and principles of extractive metallurgy, methods of processing raw materials, obtaining strategic, critical metals, innovative, modern technologies for extracting metals from raw materials. Content: The course examines the role of extractive metallurgy in the mining and metallurgical sector. Thermodynamics of metallurgical processes. Phase diagrams, phase transformations and prediction of metal properties. Measurement and evaluation of the physical properties of metals at high temperatures. Transport phenomena and properties of metals. Kinetics of metallurgical reactions. Thermoanalytical methods of metal processing. Critical, strategic raw materials of extractive metallurgy. Complex processing of mineral, resistant raw materials. Pyrometallurgical processing of critical raw materials. Innovative technologies of pyrometallurgical processing of metals.	5				V	V	V			
Cycle of profile disciplines Component of choice												
18	Technologies for extracting metals from	Purpose: Studying the theory and modern technologies of	5				V			V	V	

	slags	metal extraction from slags, acquiring skills to solve specific problems on the technology of extraction of copper, lead and other metals from oxide and oxide-sulfide melts (slag, slag and matte melt). Content: Modern ways of processing accumulated and current slag waste. New processes of additional extraction of non-ferrous and valuable metals from slags. Characteristics of non-ferrous and ferrous metallurgy slags, features of structure, forms of non-ferrous and valuable metals in slags. Selection and justification of methods of slag processing, economic analysis and evaluation of possible processing. Waste-free, environmentally friendly technologies of slag processing with complex extraction of valuable metals and the use of demetallized silicate part for the production of building materials.										
19	Technologies of processing of secondary raw materials	In this discipline are studied: Processing of secondary raw materials of some heavy non-ferrous, noble, light and rare metals. The main sources of scrap and waste, their classification and characteristics. The design of the main and auxiliary equipment for the preparation of scrap and waste for metallurgical processing. Modern pyrometallurgical and hydrometallurgical methods of processing of secondary raw materials, the main technological schemes and hardware registration of processes of production of the main heavy, rare, light and noble metals from lump waste, slags, dusts, slurries, industrial solutions and a number of other secondary waste.	4									
20	Chemistry of complex compounds	Give master's students knowledge of the chemistry of complex compounds (CC), CC in the nature of the chemical bond, their structure, transformation in solution and solid phase; main directions of CC use in industry, science and technology.	4									
21	Chlorine and vacuum technologies in metallurgy	Purpose: Study of the theory and technology of chlorination and vacuum metallurgy, acquiring skills to solve specific problems on chlorination and vacuum technology of non-ferrous and rare metals. Apparatus design of chlorination and vacuum technology, their features and disadvantages. Content: Modern ways of processing various raw materials using chlorine and vacuum technology. Characteristics of chlorides and thermodynamics of chlorination, forms of non-ferrous and valuable metals. Selection and justification	5				V		V		V	

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		of chlorine and vacuum technology in the processing of materials containing non-ferrous and valuable metals, economic analysis and evaluation.										
22	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 strategic, project and operational management.	5	V	V	V						
23	Recycling technologies in ferrous and non-ferrous metallurgy	Purpose: Master's students mastering the current level of engineering knowledge in the field of recycling technologies in ferrous and non-ferrous metallurgy. Preparation of master students to work at enterprises, research institutes and laboratories related to recycling of metallurgical wastes. Content: The majority of metallurgical waste is stored in accumulators near populated areas, which creates a threat of soil and water pollution and harms the health of residents and the environment in general. With the increasing tendency to tighten the requirements to ecology, the issue of rational use and recycling of waste and slag generated in metallurgical production is acute. In this regard, the study of the theory and practice of modern processes of recycling of metallurgical waste, which is the disposal of metallurgical enterprises from accumulated and generated production waste with the possibility of recycling products, is the main focus of this course. Taking into account that metallurgical production wastes are valuable raw materials for obtaining by-products or for reuse in the technological process, this course will pay special attention to new recycling processes, the application of which are of great interest to the existing large metallurgical plants in Kazakhstan.	5				V			V	V	
24	Mass transfer in heterophase metallurgical systems	Purpose: to give knowledge about the transfer of matter (mass) within one phase and (or) between different phases. Content: Basic concepts and general characteristics of mass transfer, its types and stages. The rule of phases. The balance line. Systems: gas-liquid, steam-liquid, liquid-liquid,	5					V		V	V	

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		liquid-solid, solid-solid. Calculation of mass transfer and mass transfer coefficients.										
25	Processes and production of super-pure metals	Purpose: Theoretical foundations of modern methods of obtaining ultrapure metals, widely used in the field of high technology, acquiring skills to solve specific problems on the technology of obtaining extremely pure non-ferrous metals. Content: Apparatus and technology for obtaining extra pure metals in non-ferrous metallurgy. Refining and purification of base metals from impurities in non-ferrous metallurgy. Influence of apparatus pressure, neutral gas and temperature for fractional separation of volatile components of non-ferrous metals and their compounds. Zone crystallization and condensation processes for obtaining particularly pure metals. Vacuum and plasma production of especially pure metals.	5				V	V			V	
26	Technologies of processing of uranium-containing raw materials	The purpose: is to provide masters with a systematic knowledge of the processing technology of uranium solutions, formed during underground borehole leaching of uranium (ISL); on the properties and characteristics of precipitators, ion-exchange resins and uranium extractants from solutions; on kinetics and thermodynamics, mechanisms of chemical reactions in the hydrometallurgical technology of natural uranium processing. Content: General technological scheme of hydrometallurgical processing of uranium ores. Interaction of leaching reagents with uranium ores, qualitative and quantitative composition of uranium solutions. The processing of uranium solutions with the use of cation exchangers and anion exchangers. Methods desorption of uranium with ion-exchange resins. The processing of uranium solutions with the use of alkylamines. Processing of uranium solutions using neutral extractants.	5				V		V	V		
27	Electrometallurgical methods of metal extraction	Purpose: To study the extraction of metals by electrometallurgical methods Content: Electroextraction processes in zinc and nickel production. Electrodialysis processes in alkali production. Electrodialysis processes in wastewater treatment of metallurgical enterprises. Use of equipment with fabric diaphragms in electroextraction and electrodialysis. Use of cation- and anion-exchange membranes in electroextraction	5					V	V			V

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		and electro dialysis.										
28	Plasma metallurgy	The purpose of the course: is to form students ' systematic knowledge about the basic principles of plasma metallurgy, technologies in ultra-high temperatures, which open up new opportunities for processing metallurgical raw materials associated with a significant concentration of thermal energy and high rates of basic reactions. Content: To carry out studies of the effect of operating parameters on the technological characteristics of plasma processes; compare different vacuum plasma methods, possess practical skills in the technology plasma equipment, use of instrumentation to determine the operating parameters of vacuum plasma processes.	5				V	V		V		

5. Curriculum of the educational program

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



«APPROVED»
Decision of the Academic Council
NPJSC «KazNRTU»
named after K.Satbayev»
dated 06.03.2025 Minutes № 10

WORKING CURRICULUM

Academic year

2025-2026 (Autumn, Spring)

Group of educational programs

MI17 - "Metallurgical Engineering"

Educational program

7M07204 - "Metallurgy and mineral processing"

The awarded academic degree

Master of Technical Sciences

Form and duration of study

full time (scientific and pedagogical track) - 2 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	4 sem	
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)													
CYCLE OF BASIC DISCIPLINES (BD)													
M-1. Module of basic training													
LNG213	Foreign language (professional)		BD, UC	3	90	0.0/30	60	E	3				
HUM214	Psychology of management		BD, UC	3	90	150/15	60	E	3				
MEI235	Engineering calculations in metallurgy	1	BD, CCH	5	150	300/15	105	E	5				
MET289	Theory and calculations of metallurgical thermodynamics and kinetics	1	BD, CCH	5	150	300/15	105	E	5				
MET242	Technologies and processes of distillation and condensation in metallurgy	2	BD, CCH	5	150	300/15	105	E	5				
MET759	Technology and refining of radioactive metals	2	BD, CCH	5	150	300/15	105	E	5				
MNG781	Intellectual property and research	2	BD, CCH	5	150	300/15	105	E	5				
HUM212	History and philosophy of science		BD, UC	3	90	150/15	60	E		3			
HUM213	Higher school pedagogy		BD, UC	3	90	150/15	60	E		3			
MET263	Current and future technology for the processing of ore and technogenic raw materials	1	BD, CCH	5	150	30/15.0	105	E			5		MET259, MET273
MET758	Technology and refining of precious metals	1	BD, CCH	5	150	300/15	105	E			5		
MNG782	Sustainable development strategies	1	BD, CCH	5	150	300/15	105	E			5		
M-3. Practice-oriented module													
AAP273	Pedagogical practice		BD, UC	8				R			8		
CYCLE OF PROFILE DISCIPLINES (PD)													
M-2. Module of professional activity													
MET757	The theory of process of metallurgical engineering		PD, UC	5	150	300/15	105	E	5				
MET752	Current and future technologies for processing raw materials of ferrous and nonferrous metallurgy		PD, UC	5	150	30/15.0	105	E	5				
MET760	Special methods of hydrometallurgy		PD, UC	5	150	300/15	105	E		5			
MET751	The technology of selection and disposal of toxic elements from the metallurgical raw materials		PD, UC	5	150	300/15	105	E		5			
MET243	Technology of extracting metals from slag	1	PD, CCH	5	150	300/15	105	E		5			MET117, MET123
MET283	Chlorine and vacuum technologies in metallurgy	1	PD, CCH	5	150	30/15.0	105	E		5			MET223, MET280
MNG705	Project Management	1	PD, CCH	5	150	300/15	105	E		5			

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MET281	Recycling technologies in ferrous and non-ferrous metallurgy	2	PD, CCH	5	150	30/15/0	105	E		5			MET223, MET280
MET761	Mass transfer in heterophase metallurgical systems	2	PD, CCH	5	150	30.0/15	105	E		5			
MET762	Special chapters of extractive metallurgy (in English)		PD, UC	5	150	30.0/15	105	E			5		
MET239	Processes and production of super-pure metals	1	PD, CCH	5	150	30.0/15	105	E			5		MET115, MET140, MET114, MET117, MET133
MET295	Technologies of processing of uranium-containing raw materials	1	PD, CCH	5	150	30.0/15	105	E			5		
MEI200	Electrometallurgical methods of metal extraction	2	PD, CCH	5	150	30.0/15	105	E			5		
MET763	Plasma metallurgy	2	PD, CCH	5	150	30.0/15	105	E			5		
MET720	Technologies of processing of secondary raw materials	1	PD, CCH	4	120	15/15/0	90	E				4	
MET235	Chemistry of complex compounds	1	PD, CCH	4	120	15/15/0	90	E				4	CHE192

M-3. Practice-oriented module

AAP256	Research practice		PD, UC	4				R				4	
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M-4. Experimental research module

AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R	4				
AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R		4			
AAP251	Research work of a master's student, including internship and completion of a master's thesis		RWMS	2				R			2		
AAP255	Research work of a master's student, including internship and completion of a master's thesis		RWMS	14				R				14	

M-5. Module of final attestation

ECA212	Registration and protection of the master 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			
		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	20	15	35
PD	Cycle of profile disciplines	0	29	24	53
Total for theoretical training:		0	49	39	88
RWMS	Research Work of Master's Student				24
ERWMS	Experimental Research Work of Master's Student				0
FA	Final attestation				8
TOTAL:					120

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Minutes № 3 dated 20.12.2024

Decision of the Academic Council of the Institute. Minutes № 4 dated 12.12.2024

Signed:

Governing Board member - Vice-Rector for Academic Affairs

Uskenbayeva R. K.

Approved:

Vice Provost on academic development

Kalpeyeva Z. B.

Head of Department - Department of Educational Program
Management and Academic-Methodological Work

Zhumagaliyeva A. S.

Director - Mining and Metallurgical Institute named after
O.A. Baikomurov

Rysbekov K. .

Department Chair - Metallurgy and mineral processing

Barmenshinova M. .

Representative of the Academic Committee from Employers

Ospanov Y. A.

____ Acknowledged ____

