Mining and Metallurgical Institute named after O.A. Baikonurov
Department of Metallurgy and Mineral Processing

TWO-DEGREE EDUCATIONAL PROGRAM

7M07226 – Mineral processing

Code and classification of the field of education:	7M07 – Engineering, manufacturing and construction industries
Code and classification of training areas:	7M072 – Manufacturing and processing industries
Group of educational programs:	M118 – Mineral processing
The level of the NRK:	Level 7 – Postgraduate education. Master's degree (based on the mastered bachelor's degree program), practical experience.
ORC Level:	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
Duration of training:	2 years
Volume of loans:	120

Almaty, 2023

Two-degree educational program "7M07226 – Mineral enrichment" was approved at a meeting of the Academic Council of KazNTU named after K.I. Satpayev.

Protocol no. 5 from "24" 11 2022 y.

Reviewed and recommended for approval at a meeting of the Educational and Methodological Council of Kazntu named after K.I.Satpayev.

Protocol no. 3 from "17" 11 2022 y.

Two-degree educational program "7M07226 – Mineral enrichment" was developed by the academic committee in the direction of "Manufacturing and processing industries"

Full name	Academic degree/ academic title	Post	Place of work	Signature
Chairman of the Academic Committee:				
Barmenshinova M.B.	c.t.s., assoc.prof	Head of the Department of Metallurgy and mineral processing	KazNTU named after K.I. Satpayev	
Teaching staff:				
Shautenov M.R.	c.t.s., docent	Prof. of the Department of Metallurgy and mineral processing	KazNTU named after K.I. Satpayev	
Employers:				
Jetybaeva U.K.	-	Chief metallurgist	LLP «KAZ Minerals»	
Students				
Smolkova A.I.	-	3rd year doctoral student	KazNTU named after K.I. Satpayev	

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List of abbreviations and designations

NAO "Kazakh National Research Technical University named after K.I.Satpayev" – NAO KazNITU named after K.I.Satpayev;

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

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

OP – educational program;

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

SROP – independent work of the student with the teacher (independent work of the student (master's student, doctoral student) with the teacher);

RUP – working curriculum;

CAD – catalog of elective disciplines;

VK – university component;

KV – component of choice;

NRK – National Qualifications Framework;

ORC – Industry qualifications framework;

RO – learning outcomes;

CC – key competencies.

1. Description of the educational program

Introduction to the educational program. The development of an innovative economy initially forms the so–called double helices of interaction - between universities (science) and business, business and government, etc., which then form a "triple spiral". Within the framework of the triple helix model, interdisciplinary knowledge is generated, developed by interdisciplinary teams united for a short time to work on a specific problem of the real world. In the triple helix model, universities, along with educational and research functions, additionally increase entrepreneurial functions by actively participating in the cultivation of startups 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 deep training of specialists in narrowly focused specialization, has led to the emergence of interdisciplinary barriers and hindering the development of new "growth points" that are located at the junctions of disciplines.

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

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

The program is comprehensive and knowledge-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 processing industry, adapted to activities in high-tech sectors of the economy of the Republic of Kazakhstan on the basis of the development of priority areas of science

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

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

The duration of the master's degree is determined by the amount of academic credits mastered. 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 mastered. The scientific and pedagogical Master's degree program provides 120 academic credits for the entire period of study, including all types of educational and scientific activities of a graduate student.

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 training.

The Master's degree in 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 Master's degree program consists of:

1) theoretical training, including the study of cycles of basic and core 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 master's degree

4) final certification.

The educational program includes the following stages of preparation of undergraduates: English (professional), management psychology, history and philosophy of science, higher school pedagogy, ore preparation and pre-concentration, geotechnological methods of complex processing of poor mineral raw materials, theory and practice of processing of gold-bearing raw materials, special chapters of the theory of flotation processes, hardware and technological features of the process of ore preparation, waste-free technologies enrichment production, modern technologies for the enrichment and processing of mineral raw materials and man-made waste, theory and practice of processing uranium-containing ores and concentrates, theory of separation of minerals in the enrichment processes, promising areas of mineral enrichment, wastewater treatment processes of processing plants, thickening and dehydration of mineral raw materials, filtration and drying of processed and enriched products, project management, labor protection and environment in the processes of mineral processing, modern methods of designing mineral processing facilities, chemistry of surface phenomena of the flotation process, theory and practice of polymetallic ore processing, theory and

practice of processing rare metal ores, theory and practice of processing non-ferrous metal ores.

The ability 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* magistracy "Mineral enrichment" can perform 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 for the production and sale of processing processing products; for the development of regulatory and technical documentation of the mining and processing sector; for the improvement and preparation of mining and processing facilities. Graduates gain knowledge in the field of development and implementation of enrichment technologies, graduates have high leadership and organizational qualities; they are capable of creating small knowledge-intensive mining and processing businesses.

The mission of the Master's degree program "Mineral enrichment" on the basis of the specialty 6M073700 – "Mineral enrichment" is the formation of students' socio-personal qualities and professional competencies that allow graduates to successfully solve production and technological, organizational and managerial, project tasks in the field of mineral enrichment, 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 mineral processing, specializing in the implementation of promising fundamental, innovative, digital and applied research and development and implementation of modern technological processes that ensure high quality products with minimal costs.

Objects of professional activity.

The objects of professional activity of graduates are processing plants, enterprises of chemical, mining, chemical and machine-building industries, branch research and design institutes, factory laboratories, higher and secondary vocational educational institutions, state management bodies and organizations of various organizational and legal forms.

Types and subjects of professional activity.

The subjects of professional activity are technological processes of the mining and processing industry, processing of raw materials, equipment of mining and processing production, automatic control systems of processing production and quality control of final products.

2. The purpose and objectives of the educational program

The purpose of EP "7M07226 – Mineral enrichment" is:

– formation of personnel for the mining and processing industry, covering modern energy-saving technologies, project activities, innovative solutions, entrepreneurship in the high-tech field of mineral and man-made raw materials enrichment.

The objectives of the EP "7M07226 – Mineral enrichment" are: – the competence of graduates in design and technological work in the implementation of projects to improve and optimize enrichment 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 processing mineral, natural and man-made raw materials;

– competence of graduates in the assessment of innovation and technological risks in the introduction of new technologies;

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

– competence in the marketing of high-tech technologies.

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

Requirements for the key competencies of graduates of the scientific and pedagogical Master's degree

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;
- about the possibilities of advanced scientific methods and technical means, to use them at the level necessary for the study of mining and processing 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 enrichment processes, features of the activities of institutions, organizations, enterprises and related industries;
- goals and objectives facing a specialist in the field of mineral processing for the development and implementation of the latest high-tech production technologies;
- methods of research of processing and 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;
- 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 processes, to justify regime 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;
- develop environmental protection measures for enrichment 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;
- to use the acquired knowledge for the original development and application of ideas in the context of scientific research;
- critically analyze existing concepts, theories and approaches to the analysis of processes and phenomena;
- integrate knowledge gained 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;

B 2 - The ability to independently apply methods and means of cognition, learning and self-control to acquire new knowledge and skills, including in new areas directly unrelated to the field of activity.

B 3 - 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 enrichment;

B8 - Basic knowledge of waste management, metal recycling.

B9 - Possession of modern and promising technologies of enrichment 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.

P3 - ready to install, adjust and operate production systems for mineral processing;

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 processes, justify regime 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 mineral processing

P14 - Be able to develop environmental protection measures for enrichment 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 processes in order to increase the extraction of valuable components contained therein

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

O 1 - 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 activity in the field of enrichment;

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 the Kazakh (Russian) language in my professional activity in the field of enrichment;

O3 - to know and apply the basics 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

From 1 - 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;

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 plants, factories, production lines.

4. Passport of the educational program

4.1. General information

№	Field name	Note
1	Code and classification of the field of education	7M07 - Engineering, manufacturing and construction industries
2	Code and classification of training areas	7M072 - Manufacturing and processing industries
3	Group of educational programs	M118 – Mineral processing
4	Name of the educational program	Mineral enrichment
5	Brief description of the educational program	The educational program "Mineral enrichment" includes fundamental, natural science, general engineering and professional training of masters in the field of mineral enrichment in accordance with the development of science and technology, as well as the changing needs of the mining and processing industry.
6	Purpose of the EP	formation of personnel for the mining and processing industry, covering modern energy-saving technologies, project activities, innovative solutions, entrepreneurship in the high-tech field of mineral and man-made raw materials enrichment
7	Type of EP	New
8	The level of the NRK	Level 7 – Postgraduate education. Master's degree (based on the mastered bachelor's degree program), practical experience.
9	ORC Level	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 the EP	Two - degree Educational Pr
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:	RO1 - speak a foreign (primarily English) language in the field of professional activity and interpersonal communication; understand the philosophical concepts of natural science, the role of natural sciences in the development of a scientific worldview; have an idea of the most relevant areas of research in the field of mineral enrichment. PO2 - understand the principles of work and are able to work on modern scientific equipment when conducting scientific research in the field of mineral enrichment; possess modern computer technologies used in processing the results of scientific experiments and collecting, processing, storing and transmitting information when conducting independent scientific research; analyze scientific literature, are able to identify and analyze problems, plan a strategy their solutions. RO3 - possess the theoretical foundations and practical skills of physical and experimental research methods in mineral enrichment; have experience of professional participation in scientific discussions; know the organizational forms and principles of the learning process and pedagogical control. RO4 - process and evaluate the results of research work; are able to apply the methods of technical and economic analysis; are able to choose research methods, plan and conduct the necessary experiments, interpret the results and draw conclusions; are able to carry out elements of mineral enrichment projects.
13	Form of training	Full - time full
14	Duration of training	2 years
15	Volume of loans	120
16	Languages of instruction	Kazakh/Russian
17	Academic degree awarded	Master of Technical Sciences
18	Developer(s) and authors:	Барменшинова М.Б.

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

№	Name of the discipline	Brief description of the discipline	Кол-во кредитов	Generated learning outcomes (codes)			
				LO1	LO2	LO3	LO4
Cycle of basic disciplines University component							
1	English (professional)	The course is designed for undergraduates of technical specialties to improve and develop foreign language communication skills in the professional and academic field. The course introduces students to the general principles of professional and academic intercultural oral and written communication using modern pedagogical technologies (round table, debates, discussions, analysis of professionally-oriented cases, design). The course ends with a final exam. Undergraduates also need to study independently (MIS).	5	V	V		
2	Management Psychology	The course is aimed at teaching undergraduates the basics of management psychology. It will consider the specifics of management psychology, psychological patterns of managerial activity, personality and its potential in the management system; motivation and effectiveness in the organization, leadership and leadership in modern management of organizations, social group as an object of management, psychological foundations of managerial decision-making, business communication and managerial conflicts, psychology of responsibility, image creation, how an integral part of the culture of communication, the psychology of advertising.	3	V	V		
3	History and philosophy of science	The subject of philosophy of science, dynamics of science, specifics of science, science and pre-science, antiquity and the formation of theoretical 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		
4	Higher school pedagogy	The course is intended for undergraduates of the scientific and pedagogical magistracy of all specialties. 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 study human resource management in educational organizations (using the example of a higher school).	3	V	V		
5	Philosophical and methodological problems of science and technology	Philosophy and Science: forms and prospects of interaction. Methodology of science. History of science and technology. Scientific and engineering creativity. The philosophy of technology. Modern trends in the science of development and their understanding. The ethical dimension of science and technology	3	V	V		

6	Professional training in English	Practical basics of public presentation of scientific and technical information in Russian. Examples of scientific presentations of the results of materials science studies, studies of embedded and non-destructive testing of structures. General information about the development of modern scientific and technical articles in English. Examples of scientific and technical articles in English, their translation and analysis.	6	V	V		
7	Modern processes and devices for processing mineral and man-made raw materials	The source of origin of technogenic raw materials. Distinctive features of technogenic and biogenic raw materials. Overview of modern processes and equipment for processing mineral and man-made raw materials. Promising processes of application of products repeated from a technogenic drive.	6		V	V	V
8	Modern methods of scientific research in chemical technology	Methods of crystal structure research. Radiography. Elemental analysis of the substance. Electron microscopy. Neutronography, neutron activation analysis. Complex thermal analysis.	3			V	V
9	Physics and chemistry of nanomaterials	Introduction. General concepts of nanomaterials and nanotechnology. Production of nanopowders and nanostructured bulk materials. Sol-gel technology for the production of nanomaterials. Carbon nanomaterials. Study some properties of nanoscale objects.	3			V	V
10	Planning and processing of experiments in chemical technologies	General issues of planning and organization of the experiment. Methods of data analysis. Methods of planning experiments. Planning an experiment while searching for optimal conditions.	3		V	V	V
Cycle of basic disciplines Component of choice							
11	Ore preparation and pre-concentration	In this discipline, the following are studied: Technological processes of preparation and enrichment of ores; design of the equipment used; methods of calculation and selection of main and auxiliary equipment; operation of crushing and crushing and processing equipment.	5		V	V	
12	Geotechnological methods of complex processing of poor mineral raw materials	The discipline studies methods of geotechnological mining, as well as characteristics of the properties of rocks and minerals, in order to determine the possibility of transferring the extracted minerals to a mobile state. The issues of physico-chemical bases of technological processes are considered. The schemes of geotechnological processing of uranium, gold, manganese, iron ores and non-metallic minerals are studied, and the processes of processing geotechnical products are also considered. The economic, environmental and social aspects of geotechnological methods of mineral enrichment are considered.	5		V	V	
13	Theory and practice of processing gold-containing raw materials	In this discipline are studied: The material composition of gold ores. The technology of processing gold ores using processing and metallurgical operations. Refining. Associated extraction of gold in the processing of copper and zinc concentrates. Technologies for processing secondary raw materials containing precious metals. Environmental aspects in the processing of gold-containing raw materials.	5			V	V
14	Special chapters of the theory of flotation processes	This course outlines the theoretical foundations of the flotation process. The basic concepts of the flotation method of mineral raw material enrichment, the variety and complexity of physico-chemical processes occurring in the flotation pulp are given. The current state of the most pressing issues of flotation theory is described: preparation of	5			V	V

		minerals for flotation, interphase interactions, mechanism of action of flotation reagents, kinetics of flotation, etc. Attention is paid to new directions in the field of flotation: foam separation, ion and column flotation, electroflotation and the use of electrochemical technology. The possibility of solving the flotation problem based on the application of capillary physics equations is shown.					
15	Hardware and technological features of the ore preparation process	In this discipline, the following are studied in detail: technological processes of ore preparation and enrichment; designs of the equipment used; methods of calculation and selection of main and auxiliary equipment; operation of crushing and grinding and processing equipment.	5		V	V	
16	Waste-free technologies of enrichment production	In this discipline, such production methods will be studied that ensure the fullest possible use of the processed raw materials and the waste generated at the same time. The principles of waste-free technologies, requirements for waste-free production, the main directions of waste-free and low-waste technologies, waste processing and use will be studied. Information is given on the processing of multi-tonnage dump waste from mining and processing plants with the release of ready-made building materials.	5		V	V	
Cycle of profile disciplines University component							
17	Modern technologies for the enrichment and processing of mineral raw materials and man-made waste	Modern technologies for the enrichment and processing of mineral raw materials and man-made waste containing various valuable metals. Basic knowledge and skills in the field of processing of mineral and man-made raw materials, characteristic features of modern technologies of metal enrichment, sources and main processes of processing of mineral and man-made raw materials; as well as methods for increasing the extraction of metals and reducing the cost of reagents, electricity and various materials. After completing the course, the student must demonstrate the ability to navigate through the variety of enrichment methods used for processing mineral and man-made raw materials, as well as calculate costs when using modern technologies. At the end of the course, a master's student should know: basic technologies for processing and extracting metals from ores and concentrates, as well as man-made mineral formations; methods of engineering calculations.	5		V	V	V
18	Theory and practice of processing uranium-containing ores and concentrates	In this discipline are studied: The material composition of uranium ores. The technology of processing uranium ores. The main stages of uranium production. Ore enrichment. Extraction of uranium from ores and concentrates by leaching. Processing of productive solutions. Sorption technology for processing productive solutions. Methods of concentration and separation of uranium from commercial desorbates. Environmental aspects of processing uranium ores and concentrates.	5		V	V	V
19	Theory of mineral separation in enrichment processes	The theoretical foundations, types and indicators of processing processes, patterns of separation of mineral particles in the working areas of processing machines and technological schemes, methods of modeling separation processes are considered. The issues of separation of minerals in the processes of ore enrichment are studied based on differences in the properties of the separated minerals. In this case, the difference in the physicochemical properties of the surface of minerals is used, namely, the difference in	5		V	V	V

		their specific free surface energies, separating media and their properties: density (specific gravity), viscosity, etc.					
20	Promising directions of mineral raw material enrichment	The main trends in the development of ore preparation processes of raw materials, flotation, gravity, magnetic and electric enrichment processes and the devices used, as well as the main trends in the development and improvement of processes that are used in the dehydration of mineral processing products. Basic knowledge and skills in the field of mineral processing will be presented. After completing the course, the master's student must demonstrate the ability to navigate the entire variety of enrichment methods used for processing mineral raw materials; analyze the information obtained during the research. A master's student should be able to: navigate the variety of processes and devices used in enrichment; use modern techniques; use technical literature.	5			V	V
21	Wastewater treatment processes of processing plants	The composition of wastewater from processing plants. Polluted and conditionally clean wastewater from processing plants. The composition of wastewater from gravity, gold recovery and flotation processing plants. The main pollutants are coarse impurities, acids and alkalis, metal ions, organic reagents, cyanides, rhodonides, phenols and cresols, petroleum products, other flotation reagents. MPC of wastewater. Methods of wastewater treatment up to the maximum permissible MPC. Mechanical wastewater treatment.	5			V	V
22	Design of modern production facilities for processing mineral and man-made raw materials	General information about mineral and man-made types of raw materials as an object for industrial processing. The pre-project stage of designing modern production facilities for processing mineral and man-made raw materials. The design stage of the design of modern production facilities for the processing of mineral and man-made raw materials. Working documentation. Course project.	6			V	V
23	Basics of granulation of dispersed materials	Methods of compaction of dispersed materials. The main elements of the theory of granulation. The mechanism of granulation. Lumpability of dispersed materials and criteria for evaluating their molding properties. Heat treatment conditions for chemical openness and granule structure.	3			V	V
24	Technologies of silicate composite materials	A general idea of composite materials. Fibrous composite materials. Composite binders and glass-crystal composites.	3		V	V	V
Cycle of profile disciplinesКомпонент по выбору							
25	Thickening and dehydration of mineral raw materials	The discipline contains the basics of the theory and mechanisms of the processes of dehydration of enrichment products and hydrometallurgy, dehydration processes in the presence of flocculants; introduces in detail the equipment and equipment used for these processes, the methodology of technological calculations of these processes.	5		V	V	
26	Filtration and drying of processed and enriched products	The discipline contains the basics of the theory and mechanisms of the processes of dehydration of enrichment products and hydrometallurgy, dehydration processes in the presence of flocculants; introduces in detail the equipment and equipment used for these processes, the methodology of technological calculations of these processes.	5		V	V	V
27	Project management	After successful completion of the discipline, undergraduates will gain knowledge about the key components of project management, with an emphasis on modern behavioral models of project-oriented business development management. The course program is based on the international standards PMI PMBOK, IPMA ICB and national standards of	5	V	V		

		the Republic of Kazakhstan in the field of project management recognized by the business community. The features of organizational management of business development through projects in the relationship of strategic, project and operational management are studied. The system of practices, methods and procedures used in the innovative activity of organizations is considered, taking into account the psychological aspects of team building, communication and interaction with stakeholders.					
28	Labor and environmental protection in mineral processing processes	Sources of environmental pollution. Wastewater and recycled water treatment. Dust suppression and dust collection. Waste storage. Safety and industrial sanitation. Safety measures during maintenance of machines and mechanisms. Industrial injuries. Accident response plan.	5		√	√	√
29	Modern methods of designing mineral processing facilities	The discipline studies general information about the design and design of mining and metallurgical enterprises, initial data for design, selection and justification of qualitative indicators of enrichment and productivity of factories and individual workshops. Selection and calculation of technological and water-sludge enrichment schemes, selection and calculation of main and auxiliary equipment. Organization of design of buildings and structures, general principles of equipment layout. Repair, storage and tail facilities, master plan. CAD elements in the design of processing plants.	5			√	√
30	Chemistry of surface phenomena of the flotation process	The universality of the flotation process is ensured by the fact that if the "natural" difference in the surface energy values of the separated minerals is small and insufficient for effective flotation separation, then it can be increased with the help of special reagents called flotation, the selective fixation of which on the surface of certain minerals changes their surface energy in a given direction. The parameters and properties of the phases of the flotation system and the main processes occurring during the interaction of phases in the volume of the liquid phase and on the mineral surface are described: hydration, dissolution and hydrolysis. The basic physico-chemical and flotation properties of collecting reagents and foaming agents, as well as the mechanism of their interaction with the mineral surface, are considered	5		√	√	√
31	Theory and practice of polymetallic ore processing	Polymetallic ores, in which valuable components are minerals of lead, zinc, copper, precious metals, in some cases tin minerals are a very complex object for mechanical enrichment. The associated extraction of precious metals significantly affects the profitability of processing of this mineral raw material. The optimal method of processing polymetallic ores is flotation enrichment.	5		√		√
32	Theory and practice of processing rare metal ores	Types and deposits of rare ores. Their technical characteristics and classification by chemical and mineralogical composition. Preliminary enrichment of ores and placers of rare metals. Ore preparation operations in the processing of ores and placers of rare metals. Technology of enrichment and integrated use of the main types of ores and placers (tungsten and tungsten-molybdenum, tin and tin-polymetallic ores, titanium-zirconium ores and placers, tantalum-niobium ores and placers, etc.)	5		√		√
33	Theory and practice of processing non-ferrous metal ores	Types and deposits of non-ferrous metal ores. Their technical characteristics and classification by chemical and mineralogical composition. Preliminary enrichment of ores. Ore preparation operations during ore processing. Technology of enrichment and	5			√	√

		integrated use of the main types of ores.					
34	Technological features of technogenic raw materials	Classification of sources of technogenic raw materials. Technological assessment of technogenic raw materials. Technological features of processing of technogenic raw materials.	3		V	V	V
35	Synthesis and kinetics of the processes of phase formation of silicate materials	In the discipline, the method of thermodynamic analysis of the components of silicate formation in two- and three-component components. Behavior of a solid body under heating. Sintering and melting. The main types of transformations of solids. Mechanism of action in mixtures of solids. Kinetics of solid-phase processes. Methods for studying the kinetics of solid-phase gases. A feature of the kinetics of the flow involving solid phases. Kinetic models and equations of isothermal kinetics. Formal equation of kinetics and determination of its parameters. Diffusion models. Kinetics of solid-phase gases in polydisperse reflections. The models include limited processes at the interface of phases. Activation energy of solid-phase gases. The active state of solid-phase reagents and products. Methods of synthesis of solid-phase materials. Syntheses using mechanical methods of homogenization of the initial mixture (ceramic synthesis, self-propagating high-temperature synthesis, synthesis using a microwave heater). Syntheses using methods of traditional homogenization of the initial mixture (co-precipitation of salt mixtures, crystallization of salt solid solutions, sol-gel method, pyrolysis of aerosols (spray drying), cryochemical technology (freeze drying).	3		V	V	V
36	Design thinking in Engineering	Design thinking as a phenomenon: idea, history, stages. Design thinking tools for designing a new product. Practice the use of design thinking in engineering education. Basics of facilitation.	2	V	V	V	
37	Academic writing for scientific and professional purposes	Writing an abstract for a scientific article. Description of the review. Writing a report. Writing different kinds of entities. Presentation of research problems. Motivation letter. Preparation of the presentation. Business correspondence.	2		V		V
38	English language. Introduction to Professional Communication: Chemistry	Chemical engineering. Career in chemical engineering. Objects of medical engineering. Materials of the chemical industry. Technological process in the chemical industry: tools and equipment. Chemical industry markets. Safety at work. Waste disposal and resource saving	2		V		V
39	Project management	Introduction to Project Management. Project planning. Operational project management.	2			V	V
40	Hydro-mechanical processes and fundamentals of dewatering of mineral and man-made raw materials	Moisture in the materials. Classification of forms of communication with reliability. Capable of removing moisture. Processes and devices for dewatering and drying of mineral materials. Promising and combined methods of dehydration of mineral and man-made materials. Compaction of mineral and man-made raw materials.	6		V	V	
41	Technologies of special cements and products based on them	Technology of preparation of cement mineral mixture. Firing of cement mineral mixture and production of clinker. Physico-chemical bases of the process of hydration of binders and the formation of the structure of cement stone. Types of cements and corrosion of cement stone and concrete.	6		V	V	
42	Promising directions of mineral raw material enrichment	Hydrodynamic and mechanical processes. Heat exchange processes. Chemical and mass transfer processes.	6			V	V

43	Technologies of special types of ceramics	The discipline includes three modules. Features of the technology of ceramic materials from natural, synthetic and man-made raw materials. Physico-chemical fundamentals of the technology of coarse (refractory and construction) ceramics. Physico-chemical fundamentals of fine ceramics technology.	6		V	V	V
44	Calculations and design of auxiliary equipment for processing mineral and man-made raw materials	General principles and methodology of auxiliary equipment design. Calculation and design of shell-and-tube heat exchangers (TOA). Calculation and design of column mass transfer devices (KMA).	6		V	V	
45	Technologies of special glasses and glass products	The discipline includes two modules. Physico-chemical fundamentals of glass and glass products technology. Technology of glass and glass products from natural and man-made raw materials.	6			V	V

5. Curriculum of the educational program

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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board-
Rector of KazNRTU named after K.Satpayev
M.M. Begentaev
«___» _____ 2023 y.

TWO-DEGREE EDUCATIONAL PROGRAM

CURRICULUM
of Educational Program on enrollment for 2023-2024 academic year

Educational program 7M07226 - "Mineral processing"
Group of educational programs M118 - "Mineral processing"

Form of study: full-time Duration of study: 2 year Academic degree: Master of Technical Sciences

Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	Classroom amount lec/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters			
								1 course		2 course	
								1 semester	2 semester	3 semester	4 semester
CYCLE OF BASIC DISCIPLINES (BD)											
M-1. Module of basic training (university component)											
LNG210	Foreign language (professional)	BD UC	5	150	0/0/3	105	E	5			
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											
MET712	Ore preparation and pre-concentration	BD CCH	5	150	2/1/0	105	E	5			
MET255	Geotechnological methods of complex processing of mineral raw materials poor				2/1/0						
MET714	Theory and practice of processing of gold-containing raw materials	BD CCH	5	150	2/1/0	105	E	5			
MET266	Special chapters of the theory of flotation processes				2/1/0						
MET253	Hardware and technological features of process of ore dressing	BD CCH	5	150	2/1/0	105	E			5	
MET254	Non-waste technology processing industry				2/1/0						
CYCLE OF PROFILE DISCIPLINES (PD)											
M-2. Module of professional activity (university component, component of choice)											
MET708	Modern technologies of enrichment and processing of mineral raw materials and technogenic waste	PD UC	5	150	2/0/1	105	E	5			
MET753	Theory and practice of uranium ore and concentrates processing	PD UC	5	150	2/1/0	105	E	5			
MET723	The theory of the separation of minerals in beneficiation processes	PD UC	5	150	2/1/0	105	E		5		
MET284	Prospective directions of mineral processing	PD UC	5	150	2/0/1	105	E			5	
MET262	Process wastewater concentrators	PD UC	5	150	2/1/0	105				5	
MET716	Thickening and dehydration of mineral raw materials	PD CCH	5	150	1/1/1	105	E		5		
MET717	Filtration and drying of processed and enriched products				1/1/1						
MNG705	Project Management				2/0/1						
MET729	Labor and environmental protection in mineral processing processes	PD CCH	5		2/0/1	105	E		5		
MET755	Modern methods of design of mineral processing facilities			150	2/1/0						
MET274	Surface chemistry flotation process	PD CCH	5		2/1/0	105	E			5	
MET267	Theory and practice of processing of polymetallic ores			150	2/1/0						

MET268	Theory and practice of processing of ores of rare metals	PD CCH	5		2/1/0	105	E			5	
MET269	Theory and practice of processing of non-ferrous metals			150	2/1/0						
M-3. Practice-oriented module											
AAP229	Pedagogical practice	BD UC	6						6		
AAP269	Research practice	PD UC	8								8
M-4. Experimental research module											
AAP251	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	2					2			
AAP241	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	3						3		
AAP254	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	5							5	
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

Federal State Autonomous Educational Institution of Higher Education
National Research Tomsk Polytechnic University

Educational program "Processes and devices for processing mineral and man-made raw materials"
Direction of training 18.04.01 - "Chemical technology"

Form of study: full-time Duration of study: 2 year Academic degree: Master of Technical Sciences

Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	Classroom amount lec/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters			
								1 course		2 course	
								1 semester	2 semester	3 semester	4 semester
CYCLE OF BASIC DISCIPLINES (BD)											
M1 Block 1. Disciplines (modules)											
M1.BM1 Module of general scientific disciplines											
MET271	Philosophical and methodological problems of science and technology	BD UC	3	108	1/0/1	76	Exam		3		
MET272	Professional training in English	BD UC	6	216	0/0/4	152	Cre	3	3		
M1.BM2 Module of general professional disciplines											
MET782	Modern processes and devices for processing mineral and man-made raw materials	BD UC	6	216	1/1/1	152	Exam	6			
MET783	Modern methods of scientific research in chemical technology	BD UC	3	108	1/1/1	60	Exam	3			
MET784	Physics and chemistry of nanomaterials	BD UC	3	108	1/1/1	60	Cre	3			
MET785	Planning and processing of experiments in chemical technologies	BD UC	3	108	1/1/1	76	Cre		3		
CYCLE OF PROFILE DISCIPLINES (PD)											
M1.VM1 Interdisciplinary Professional Module											
MET786	Design of modern production facilities for processing mineral and man-made raw materials	PD UC	6	216	1/1/1	136	Exam		6		
MET787	Basics of granulation of dispersed materials	PD UC	3	108	1/1/1	60	Cre			3	
MET788	Technological features of technogenic raw materials	PD CCH	3	108	1/1/1	60	Exam		3		
MET789	Synthesis and kinetics of the processes of phase formation of silicate materials										
MET790	Technologies of silicate composite materials	PD UC	3	108	1/0/1	76	Cre	3			
M1.VM2 Module of university-wide elective disciplines											
MET286	Design thinking in Engineering	PD	2	72	1/0/1	40	Cre	2			
MET287	Academic writing for scientific and professional purposes										

MET288	English language. Introduction to Professional Communication: Chemistry	CCH	2	72	1/0/1	40	Cre	2			
MET769	Project management										
M1.VM3 Variable interdisciplinary professional module											
M1.VM3.1 "Processes and devices for processing mineral and man-made raw materials"											
MET791	Hydro-mechanical processes and fundamentals of dewatering of mineral and man-made raw materials	PD CCH	6	216	1/1/1	152	Exam			6	
MET792	Technologies of special cements and products based on them										
MET793	Promising directions of mineral raw material enrichment	PD CCH	6	216	1/1/1	168	Exam			6	
MET794	Technologies of special types of ceramics										
MET795	Calculations and design of auxiliary equipment for processing mineral and man-made raw materials	PD CCH	6	216	1/1/1	152	Exam			6	
MET796	Technologies of special glasses and glass products										
M2 Block 2. Dispersed practices, including research											
MET775	Pedagogical practice. Fundamentals of pedagogical activity	PD UC	1	36				1			
MET776	Pedagogical practice	PD UC	3	108					3		
MET777	Research work in the semester	PD UC	18	648				6	6	6	
M2 Block 2. Practices											
MET797	Practice on obtaining primary professional skills and abilities (educational practice)	PD UC	6	216					6		
MET798	Practice in obtaining professional skills and professional experience (including technological practice)	PD UC	9	324							9
MET780	Pre-graduate practice	PD UC	15	540							15
M3 Block 3. State final certification											
MET781	Master's final qualifying work (execution, preparation for the defense procedure and defense of the final qualifying work)	FA	9	324							9
	Total based on UNIVERSITY:							27	33	27	33

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		33	20	53
	Total for theoretical training:	***0***	***53***	***35***	***88***
	RWMS		***24***		***24***
FA	Final attestation	8			8
	TOTAL:	**8**	**77**	**35**	**120**

Decision of the Academic Council of KazNRTU named after K.Satpayev. Protocol №3, 27.10.2022 y.

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Protocol №2, 21.10.2022 y.

Decision of the Academic Council of MaMI named after O. Baikonurov. Protocol №2, 17.10.2022 y.

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

Director of the Mining and Metallurgical Institute **K.B. Rysbekov**

Head of department "Metallurgy and mineral processing" **M.B. Barmenshinova**

Representative of the employers' council of the LLP "KAZ Minerals" **U.K. Jetybaeva**

6. Additional educational programs (Minor)

Name of additional educational programs (Minor) with disciplines	Total number of credits	Recommended semesters of study	Documents on the results of the development of additional educational programs (Minor)