Mining and Metallurgical Institute named after O.A. Baikonurov
Department "Metallurgy and mineral processing"
Department of Metallurgical Processes, Heat Engineering and Technology of Special Materials

ДВУДИПЛОМНАЯ 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:	Level 7 - Postgraduate education. Master (based on the mastered bachelor's 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
Training period:	2 года
Volume of loans:	120

Алматы 2023

The educational program «7M07204 - Metallurgy and mineral processing» was approved at a meeting of the Academic Council of KazNTU named after. K.I. Satpaeva.

Protocol No. 5 dated "24" 11 2022

Considered and recommended for approval at a meeting of the Educational and Methodological Council of KazNITU named after. K.I. Satpaeva.

Protocol No. 3 dated "17" 11 2022

The educational program «7M07204 - Metallurgy and mineral processing» was developed by the academic committee in the direction "Production and manufacturing industries"

Full name	Academic degree/ academic title	Job title	Place of work	Signature
Chairman of the academic committee:				
Barmenshinova M.B.	c.t.s., associate professor	Head of the Department of MaMP	KazNITU named after K.I. Satpaeva	
Chepushtanova T.A.	PhD doctor c.t.s.	Head of the Department of MPHEaTSM	KazNITU named after K.I. Satpaeva	
Teaching staff:				
Baimbetov B.S.	c.t.s., docent	Professor of the Department of MaMP	KazNITU named after K.I. Satpaeva	
Usoltseva G.A.	c.t.s.	Associate professor of the Department of MPHEaTSM	KazNITU named after K.I. Satpaeva	
Employers:				
Ospanov E.A.	Doctor of Technical Sciences	Head of department of complex processing of technogenic raw materials	Kazakhmys Corporation LLP	
Mishra B	PhD doctor	Director of the Institute of Metalworking	Worcester Polytechnic Institute (USA)	
Students				
Nurdan M.	master	3rd year doctoral student	KazNTU named after K.I. Satpayev	

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List of abbreviations and symbols

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

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

MNiVO 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.

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 os 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, project activities, innovative solutions, entrepreneurship in the high-tech sphere of mineral processing.

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.

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	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, covering modern energy-saving technologies, project activities, innovativeness of solutions, entrepreneurship in the high-tech sphere of processing of mineral raw materials
7	EP type	New
8	NQF level	Level 7 - Postgraduate education. Master (based on the mastered bachelor's program), practical experience.
9	ORC level	Level 7 - Conceptual professional and / or scientific knowledge (including innovative) and experience in a particular area and / or at the intersection of areas. Evaluation and selection of professional information. Creation of new applied knowledge in a certain area. Identification of sources and search for information necessary for the development of activities
10	Distinctive features of the EP	Two-degree educational progpam
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. 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. 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
17	Awarded Academic Degree	master of technical sciences
18	Developer(s) 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 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).	5	V	V	V						
2	Management Psychology	The discipline studies the modern role and content of psychological aspects in management activities. The article considers the improvement of psychological literacy of the student in the process of implementing professional activity. He improves himself in psychology and studies the composition and structure of management activities, both at the local level and abroad. The psychological picture of modern managers is considered.	3	V	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	V						
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 study human resource management in	3	V	V	V						

		educational organizations (using the example of a higher school).										
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	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	V						
7	Materials science and technologies of modern and promising materials	Introduction. Technologies of metal materials. Ceramic materials technology. Technologies of individual materials. Technology of polymer materials. Hybrid materials technologies.	6				V	V	V			V
8	Modern problems of materials and process sciences	Modern materials science. Tasks and content. The basic idea of materials. The main types of materials. Approaches to the selection of materials for various tasks	3					V		V	V	
9	From research to business	Introduction. Scientific career. Financing of the project. Project management. Knowledge management. Methodology of project construction. Opportunities for commercialization of scientific results.	3				V	V	V			V
10	Special chapters of Materials Science	General issues of steel alloying. Steel structures. Tool steels. Steels and alloys with special chemical properties. Heat-resistant and heat-resistant steels and alloys. Steels and alloys with severe physical manifestations.	3				V	V	V			V
11	Nanostructured materials based on metal and ceramic	Introduction. Plasticity theory and fracture mechanics. Plasticity theory and fracture mechanics. Modern methods of manufacturing ultrafine particles. Modern research methods and principles of certification of ultrafine particles. Physical properties of nanoparticles. Methods of obtaining products and the possibility of using nanomaterials.	3				V	V	V			
Cycle of basic disciplines Component of choice												
12	Engineering calculations in metallurgy	According to the discipline, methods of thermodynamic, mass transfer and technological calculations in the	5				V	V	V			

		production of non-ferrous metals are studied, including: issues of choosing a technological scheme and basic metallurgical aggregates; drawing up material and thermal balances; plotting balance sheets; plotting dependency graphs and diagrams. Examples of drawing up algorithms for 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.											
13	Theory and calculations of metallurgical thermodynamics and kinetics	The processes occurring in metallurgical systems are considered from the standpoint of thermodynamics and kinetics. The characteristics of equilibrium and nonequilibrium processes and states of metallurgical systems are given. Theoretical provisions and conclusions about the structure and properties of metallic, oxide and sulfide systems. Basic calculations on thermodynamics and kinetics of metallurgical processes. Calculation of thermodynamic and kinetic parameters using modern digital software for calculations.	5				V	V	V			
14	Technologies and processes of rectification and condensation in metallurgy	The main regularities of evaporation and sublimation. Theory of condensation processes, features of condensation of a vapor-gas mixture. The process of rectification, the scheme of the device of the rectification column. Calculation of the distillation column. The role of external pressure in the processes of evaporation 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 extraction and condensation devices for rectification and condensation processes in non-ferrous metallurgy.	5				V	V		V		
15	Technology and refining of radioactive metals	The course provides theoretical patterns and practice of the main processes of refining radioactive metals (uranium, thorium and plutonium), technology and hardware design: precipitation and extraction purification methods in uranium technology.	5				V	V		V		
16	Modern and promising technologies for processing ore and man-made raw materials	In this discipline, environmentally safe processes of complex processing and opening of difficult-to-enrich ores and man-made deposits are studied on the basis of combining modern methods of enrichment, pyro- and	5					V		V	V	

		hydrometallurgy with the use of additional energy influences.											
17	Technology and refining of precious metals	The course studies the refining of precious metals: gold, silver (chlorine process, electrolysis refining, acid refining methods) and platinum group metals.	5				V	V		V		
Цикл профилирующих дисциплин Вузовский компонент													
18	Theory of metallurgical engineering processes	Systematized materials on oxide melts, the structure and properties of slags, as well as on the theoretical foundations of hydrometallurgical and electrometallurgical processes, in–depth knowledge of methods for analyzing diagrams of the state of slag systems, diagrams "Potential - pH", laws of electrometallurgical processes, as well as the basic laws of thermodynamics, mechanism and kinetics of the main metallurgical processes; examples of various pyro processing processes – and hydro-electrometallurgical methods; methods and examples of application of software materials for thermodynamic and kinetic analysis of processes.	5				V	V	V			V
19	Modern and promising technologies for processing raw materials of ferrous and non-ferrous metallurgy	Complex processing of raw materials of ferrous and non-ferrous metallurgy. Technologies focused on solving problematic issues and obtaining products using waste-free technology. Rational processing of raw materials. Solving problems of ecology, materials- and energy saving. Technologies for processing substandard and man-made raw materials and production waste in the country and abroad.	5					V		V	V	
20	Special methods of hydrometallurgy	Thermodynamic probability of leaching reactions of mineral raw materials with alkaline reagents. Kinetics of the leaching process. The state of metals in solutions of hydroxyl reagents. Technological features of alumina production by hydro-alkaline method. Organization of associated extraction of vanadium and gallium in the processing of alumina-containing raw materials. Ammonia hydrometallurgy. Equilibrium of complexation in aqueous-ammonia solutions. Physico-chemical prerequisites for the use of mixed solutions of sodium hydroxide and ammonia as leaching reagents. Hardware design of leaching processes. Examples of industrial use of hydro-alkaline processing of mineral and man-made raw materials. Some technological aspects and prospects for the development of ammonia hydrometallurgy.	5				V	V	V			V

21	Technology of isolation and disposal of toxic elements from metallurgical raw materials	Characteristics of secondary technogenic raw materials in metallurgy. The technology of utilization of sulfur dioxide in the industrial production of non-ferrous metals from sulfide raw materials. Disposal and neutralization of gases containing fluorine, chlorine and other harmful substances. Technology for the isolation and disposal of antimony and arsenic from the waste gases of the processing of sulfide antimony-arsenic-containing concentrates. Technology of fluorine extraction from aluminum production waste. Cleaning and disposal of industrial effluents of non-ferrous metallurgy. Selection of reagents for reclamation of contaminated lands.	5					V		V	V	
22	Special Chapters of Extractive Metallurgy (in English)	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			
23	Modern methods of structural analysis in materials science	Microstructure of materials and its parameters. Scanning electron microscopy. Diffraction analysis of the crystal structure. Transmission electron microscopy	6				V	V		V		
24	The main directions of development of materials science	Modern materials science. Tasks and content. Metal materials. Ceramics. Polymers. Composite materials. Nanostructured materials. Surface hardening. Coatings. Computer technologies in materials science.	3				V	V	V			V
25	Diagnostics of materials	Classification of non-destructive testing methods. Acoustic control methods. Magnetic control methods. Capillary control methods. Tomography. Combined acoustic–optical methods of non-destructive testing. Other control methods.	3				V			V	V	
26	Research work (obtaining primary skills of research work)	Preparatory stage: familiarization with the Regulations on TPU practices, the work program of the practice; passing instruction on familiarization with the requirements of labor protection, equipment, fire safety, internal labor regulations; filling out a diary on practice: formulation of an individual	6					V		V	V	

		task on practice and drawing up a schedule of practice. Main stage / Execution of an individual task: the stage of collecting, processing and analyzing scientific and technical information on the subject of experiments to compile reviews within the framework of an individual task. Research work: Conducting experiments and calculations on the study of materials and evaluation of their properties within the framework of the tasks; description and analysis of the results of experiments and calculations within the framework of an individual task. The final stage: filling out the implementation diary: accounting for the work performed; studying regulatory requirements, drawing up the structure and content of the application report; writing, editing, creating a list of information sources used, making applications; preparing an implementation report; issuing reports on the protection of practice.										
27	Additive manufacturing of products	Purpose, scope and classification of modern materials for additive technologies. Equipment for additive technologies. Methods for investigating the properties of the initial signal for additive manufacturing and parts obtained by 3D printing. Structure, properties and methods of changing the properties of products obtained using additive technologies.	6					V		V	V	
Цикл профилирующих дисциплин Компонент по выбору												
28	Technologies for extracting metals from slags	Physico-chemical properties of slags. Selection of slag-forming fluxes for optimal management of metallurgical processing of polymetallic raw materials. The content of valuable metals in the slags of non-ferrous and ferrous metallurgy. Existing methods of depletion of slags. Selection of technological modes, reagents and equipment for processing non-ferrous metallurgy slags in order to maximize the full extraction of valuable non-ferrous metals with the production of dump slag suitable for use in construction. Ways to reduce the content of non-ferrous metals in the resulting metallurgical slags.	5				V			V	V	
29	Chlorine and vacuum technologies in metallurgy	Modern methods of processing various raw materials using chlorine and vacuum technology. Characteristics of chlorides and thermodynamics of chlorination, forms of finding non-ferrous and valuable metals. Selection and justification of chlorine and vacuum technology in the processing of materials containing non-ferrous and precious	5				V		V		V	

		metals, economic analysis and evaluation.										
30	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 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 innovation activities of organizations is considered, taking into account the psychological aspects of team building, communication and interaction with stakeholders.	5	V	V	V						
31	Recycling technologies in ferrous and non-ferrous metallurgy	Metallurgical waste. Rational use and recycling of waste and slags. Theory and practice of modern recycling processes of metallurgy waste. Disposal of metallurgical enterprises from accumulated and generated industrial waste. Recycling technology: primary sorting, cleaning, rejection; distribution to production lines; storage of the final product; removal and burial at the landfill.	5				V			V	V	
32	Mass transfer in heterophase metallurgical systems	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, liquid-solid, solid-solid. Calculation of mass transfer and mass transfer coefficients.	5					V		V	V	
33	Processes and production of high-purity metals	Equipment and technology for obtaining especially pure metals in non-ferrous metallurgy. Refining and purification of base metals from impurities in non-ferrous metallurgy. Influence of pressure in the equipment, neutral gas and temperature for fractional separation of volatile components of non-ferrous metals and their compounds. The processes of zone crystallization and condensation for the production of especially pure metals. Vacuum and plasma production of especially pure metals.	5				V	V			V	
34	Technologies for processing uranium-containing raw materials	General technological scheme of hydrometallurgical processing of uranium ores. Interaction of leaching reagents with uranium ores, qualitative and quantitative composition of uranium solutions. Theory of ion exchange. Processing of	5				V		V	V		

		uranium solutions using cationites and anionites. Methods of desorption of uranium from ionites. Equipment of ion exchange processes. Processing of uranium solutions using alkylamines. Processing of uranium solutions using neutral extractants.											
35	Technology of fractional separation of metals from a vapor-gas mixture	The main reactions occurring during the pyrometallurgical processing of mineral raw materials. Characteristics of vertebral processes. Equipment for sublimation and condensation of vapors of non-ferrous metals and their compounds. Fractional separation and condensation of vapors of volatile components.	5				V	V		V		
36	Plasma metallurgy	To conduct research on the influence of operational parameters on the technological characteristics of plasma processes; to compare various vacuum-plasma methods, to possess practical skills of working on technological plasma equipment, to use control and measuring instruments to determine the operational parameters of vacuum-plasma processes.	5				V	V		V		
37	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	
38	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	V	
39	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	V	
40	Project management	Introduction to Project Management. Project planning. Operational project management.	2				V		V		V	
41	Methodology of materials selection in industrial technologies	Introduction to the discipline. The use of heat treatment to impart the desired properties to the material. Production of industrial products. Indicators of industrial production. The ability to harden materials.	6					V		V	V	
42	Basic principles of the choice of materials working in special conditions	General principles of materials selection. Functional requirements and limitations. Economic efficiency. Stability. Special properties.	6				V	V		V		
43	Technological solutions of product	Injection molding techniques for complex structures and	6				V	V		V		

	surface functionalization	functions. Quick and easy design change. Surfaces with diverse functionality. Surface finishing for greater durability of plastic products. Finishing the surface of plastic products using various methods of film casting. Bay technique for creating a special tactile effect.											
44	Modern technologies of surface hardening	The problem of the service life of machine parts and conditions. The role of the surface. Methods of surface hardening during its modification. Methods of surface hardening during coating. High-energy methods of surface hardening.	6				V	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 7M07204 - "Metallurgy and mineral processing"
Group of educational programs M117 - "Metallurgical engineering"

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											
MET235	Engineering calculations in metallurgy	BD CCH	5	150	2/0/1	105	E	5			
MET289	Theory and calculations of metallurgical thermodynamics and kinetics				2/0/1						
MET242	Technologies and processes of distillation and condensation in metallurgy	BD CCH	5	150	2/0/1	105	E	5			
MET759	Technology and refining of radioactive metals				2/0/1						
MET263	Current and future technology for the processing of ore and technogenic raw materials	BD CCH	5	150	2/1/0	105	E			5	
MET758	Technology and refining of precious metals				2/0/1						
CYCLE OF PROFILE DISCIPLINES (PD)											
M-2. Module of professional activity (university component, component of choice)											
MET757	Theory of mineral processing processes	PD UC	5	150	2/0/1	105	E	5			
MET752	Current and future technologies for processing raw materials of ferrous and nonferrous metallurgy	PD UC	5	150	2/1/0	105	E	5			
MET760	Special methods of hydrometallurgy	PD UC	5	150	2/0/1	105	E		5		
MET751	The technology of selection and disposal of toxic elements from the metallurgical raw materials	PD UC	5	150	2/0/1	105	E			5	
MET762	Special chapters of extractive metallurgy (in English)	PD UC	5	150	2/0/1	105				5	
MET243	Technology of extracting metals from slag	PD, CCH	5	150	2/0/1	105	E		5		
MET283	Chlorine and vacuum technologies in metallurgy				2/1/0						
MNG705	Project Management				2/0/1						
MET281	Recycling technologies in ferrous and non-ferrous metallurgy	PD, CCH	5		2/1/0	105	E		5		
MET761	Mass transfer in heterophase metallurgical systems			150	2/0/1						
MET239	Processes and production of super-pure metals	PD, CCH	5		2/0/1	105	E			5	
MET295	Technologies of processing of uranium-containing raw materials			150	2/0/1						
MET250	Technology of fractional separation of metals from the gas mixture	PD, CCH	5		2/0/1	105	E			5	
MET763	Plasma metallurgy			150	2/0/1						

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	Exam	3	3		
M1.BM2 Module of general professional disciplines											
MET273	Materials science and technologies of modern and promising materials	BD UC	6	216	1/1/1	152	Exam		6		
MET275	Modern problems of materials and process sciences	BD UC	3	108	2/0/1	76	Exam	3			
MET276	From research to business	BD UC	3	108	2/0/1	60	Exam	3			
MET277	Special chapters of Materials Science	BD UC	3	108	2/0/1	60	Exam	3			
MET278	Nanostructured materials based on metal and ceramic	BD UC	3	108	1/1/1	60	Exam			3	
CYCLE OF PROFILE DISCIPLINES (PD)											
M1.VM1 Interdisciplinary Professional Module											
MET280	Modern methods of structural analysis in materials science	PD UC	6	216	1/1/1	152	Exam	6			
MET282	The main directions of development of materials science	PD UC	3	108	2/0/1	60	Exam	3			
MET285	Diagnostics of materials	PD UC	3	108	1/1/1	60	Exam		3		
M1.VM2 Module of university-wide elective disciplines											
MET286	Design thinking in Engineering	PD CCH	2	72	1/0/1	40	Exam		2		
MET287	Academic writing for scientific and professional purposes										
MET288	English language. Introduction to Professional Communication: Chemistry										
MET769	Project management										
M1.VM3 Variable interdisciplinary professional module											
M1.VM3.1 "Technological design"											
MET770	Methodology of materials selection in industrial technologies	PD CCH	6	216	2/0/1	152	Exam			6	
MET771	Basic principles of the choice of materials working in special conditions										

MET772	Technological solutions for the functionalization of the surface of products	PD CCH	6	216	1/1/1	168	Exam			6	
MET773	Modern technologies of surface hardening										
MET774	Additive manufacturing of products	PD UC	6	216	1/1/1	152	Exam			6	
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											
MET778	Practice on obtaining primary professional skills and abilities (educational practice)	PD UC	6	216					6		
MET779	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:							28	32	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 named after O. A. Baikonurov **K.B. Rysbekov**

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

Head of department "Metallurgical processes, heat engineering and technology of special materials" **T.A. Chepushtanova**

Partner university:
Worcester Polytechnic Institute (USA) B. Mishra **B. Mishra**

Representative of the employers' council of the LLP "Kazakhmys" **E.A. Ospanov**

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)