



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

**EDUCATIONAL PROGRAM**

**6B07219 - Non-Ferrous Metals Metallurgy**

Code and classification of the field of education:	6B07 - Engineering, manufacturing and construction industries
Code and classification of areas of study:	6B072 - Manufacturing and processing industries
Group of educational programs:	B071 - "Mining and extraction of minerals"
NQF level:	Level 6 - higher education and practical experience
ORC level:	Level 6 - a wide range of special (theoretical and practical) knowledge (including innovative). Independent search, analysis and evaluation of professional information
Training period:	4 years
Volume of loans:	240

**Almaty 2023**






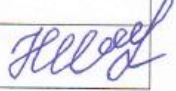
The educational program «6B07219 - Non-Ferrous Metals Metallurgy» was approved at a meeting of the Academic Council of KazNRTU named after K.I.Satpayev.

Protocol No. 5 dated "24" "11" 2022

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

Protocol No. 3 dated "17" "11" 2022

The educational program 6B07219 - Non-Ferrous Metals Metallurgy was developed by the Academic Committee for the Production and Manufacturing Industries track

Full name	Academic degree/ academic title	Job title	Place of work	Signature
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Ospanov E.A.	Doctor of Technical Sciences	head of the Department of Complex processing of technogenic raw materials	«Kazakhmys Corporation» LLP	
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<b>Students</b>				
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## **List of abbreviations and symbols**

**NAO «Kazakh National Research Technical University named after K.I. Satpayev»** - NAO KazNRTU 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**

It is intended for implementation of profile training of bachelors on educational program 6B07219 - "Metallurgy of non-ferrous metals" at Satbayev University and developed within the framework of the direction "Production and processing industries".

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

- The Law of the Republic of Kazakhstan «On Education» with amendments and additions within the framework of legislative changes to increase the independence and autonomy of universities dated 04.07.18 No. 171-VI;

- The Law of the Republic of Kazakhstan «On Amendments and Additions to Some Legislative Acts of the Republic of Kazakhstan on the expansion of academic and managerial independence of higher educational institutions» dated 04.07.18 No. 171-VI;

- Order of the Minister of Education and Science of the Republic of Kazakhstan dated 30.10.18 No. 595 «On approval of Standard rules for the activities of educational organizations of appropriate types»;

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

- Resolution of the Government of the Republic of Kazakhstan dated 19.01.12 No. 111 «On approval of Standard rules for admission to education organizations implementing educational programs of higher education» with amendments and additions dated 14.07.16 No. 405;

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

- Resolution of the Government of the Republic of Kazakhstan dated 31.12.2019 No. 1050 «On approval of the State Program of Industrial and innovative Development of the Republic of Kazakhstan for 2020-2025»;

- «National Qualifications Framework» approved by the Protocol of 16.06.2016 by the Republican Tripartite Commission on Social Partnership and Regulation of Social and Labor Relations;

- Industry Qualifications Framework "Mining and Metallurgical Complex" dated 30.07.2019 No. 1;

- Strategy «Kazakhstan-2050»: a new political course of the established state. Message of the President of the Republic of Kazakhstan - Leader of the Nation N.A. Nazarbayev to the people of Kazakhstan. Astana, 14.12.2012;

- «New development opportunities in the context of the Fourth Industrial Revolution». Message of the President of the Republic of Kazakhstan N. Nazarbayev to the people of Kazakhstan. 10.01.2018;

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

*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 in-depth 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 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 the high-tech sectors of the economy of the Republic of Kazakhstan based on the development of priority areas of science and technology, development of knowledge-intensive industries, competitive technologies in the processing of technogenic raw materials and waste.

The developed Program is the basis for a coherent and flexible system of training of 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 benefits of the Program are:*

- highly qualified continuous training of young scientists and personnel for the university and the economy of the republic on new methods and specialized Minor - programs;
- active involvement of talented students in priority research (fundamental) and scientific and technical (applied) works;
- student participation in priority scientific works, formation of new knowledge and skills, acquisition of professional work experience (seniority) to continue scientific research in master's and doctoral programs with the development of innovative technologies for the mining and metallurgical industry.

Training of specialists provides training in the main directions, each of which includes modern fundamental content necessary for training of highly qualified specialists demanded by the economy of the republic.

Educational program 6B07219 - "Non-ferrous Metallurgy" includes fundamental, natural science, general engineering and professional training of bachelors in the field of non-ferrous metallurgy in accordance with the development of science and technology, as well as the changing needs of the mining and metallurgical industry.

The distinctive feature of the program is that the program provides adaptation of the graduate to the industrial sector, due to the content of 40% of general engineering disciplines in the educational program.

The graduate receives a fundamental set of general engineering disciplines as well as a maximum set of specialized disciplines.

The program provides in-depth study of technological mineralogy, basics of mineral processing, general metallurgy, theory of metallurgical processes, metallurgy of heavy non-ferrous, noble, light, rare and disseminated metals, metallurgical heat engineering, metallurgical engineering (in English), heat and power engineering of metallurgical processes, alloying of non-ferrous metals, organization and planning of experiments, modern environmental schemes and forecasting in metallurgy.

*The area of professional activity of graduates who have mastered the Bachelor's degree program includes:*

- processes of beneficiation and processing of ores and other materials to produce concentrates and intermediates;
- processes of obtaining metals and alloys, metal products of required quality;

- Processing processes that change the chemical composition and structure of metals (alloys) to achieve certain properties.

A graduate of the program will be able to perform professional activities in the mining and metallurgical complex in engineering and working positions, at metallurgical enterprises, in design organizations, in metallurgical research centers.

*Objects of professional activity of graduates*, who have mastered the Bachelor's degree program are:

- processes and devices for enrichment and processing of mineral and technogenic raw materials with obtaining semi-products, production and processing of non-ferrous metals, as well as products made of them;

- processes and devices to ensure energy and resource conservation and environmental protection during technological operations;

– projects, materials, methods, instruments, installations, technical and regulatory documentation, quality management system, mathematical models;

– design and research divisions, production divisions.

*Types and tasks of professional activity of a graduate*

List of professional activities and corresponding professional tasks:

Types of professional activities	Professional tasks
research activities	<ul style="list-style-type: none"><li>- carrying out experimental research;</li><li>- performing literature and patent searches, preparing technical reports, information reviews, publications;</li><li>- study of scientific and technical information, domestic and foreign experience on the subject of research;</li></ul>
project analysis	<ul style="list-style-type: none"><li>- performing technical and economic analysis of the development of projects of new and reconstruction of existing shops, industrial units and equipment;</li><li>- analyzing designs and calculations of technological equipment;</li><li>- analyzing design and working technical documentation;</li><li>- development and analysis of mathematical models;</li></ul>
production activities	<ul style="list-style-type: none"><li>- realization of technological processes of enrichment and processing of mineral natural and man-made raw materials;</li><li>- implementation of technological processes of obtaining and processing of metals and alloys, as well as products made of them;</li><li>- implementation of measures to protect the environment from technogenic impacts of production;</li><li>- implementation of measures to ensure product quality;</li><li>- organization of workplaces, their technical equipment, placement of technological equipment;</li><li>- control over observance of technological discipline;</li><li>- organization of maintenance of technological equipment;</li></ul>
design and technological activities	<ul style="list-style-type: none"><li>- collection of information for feasibility studies and participation in the development of projects for new and reconstruction of existing shops, industrial units and equipment;</li><li>- calculation and design of elements of technological equipment;</li><li>- development of design and working technical documentation;</li></ul>

## **2. Goal and objectives of the educational program**

**The purpose of EP 6B07219 - "Metallurgy of non-ferrous metals" is:**

- Preparation of competitive personnel with critical thinking, fundamental and applied knowledge, research skills in the field of non-ferrous metals metallurgy, capable of making complex and effective decisions in the processing of mineral raw materials from concentrates to metals and their compounds.

**The objectives of EP 6B07219 - "Metallurgy of non-ferrous metals" are:**

- Formation of skills and abilities to choose and evaluate methods of environmental protection from anthropogenic impact in urbanized areas;

– Strengthening the technological component of classical science education, to provide knowledge of modern technologies without lowering the bar of fundamental education;

- basics of development and carrying out fundamental and applied research in the field of non-ferrous metals metallurgy using new achievements of technologies, new generation techniques and ecomonitoring of enterprises;

- ensuring the interaction of fundamental and applied science with the educational process at all its stages, including the use of the results of joint research work in lecture courses, experimental base for the performance of educational and research, laboratory and course work, industrial and pre-graduation practice;

- ensuring training and retraining of personnel for the domestic mining and metallurgical sector in close cooperation with state corporations and the real sector of the economy, employment of graduates in knowledge-intensive innovative companies and other research centers.

### **3 Requirements for assessment of learning outcomes of the educational program**

Because of mastering the educational program of Bachelor's degree 6B07219 - "Metallurgy of non-ferrous metals», the graduate should have general cultural, general professional and professional competences.

A graduate who has mastered the Bachelor's degree program shall possess the following competencies:

*general cultural competencies:*

- ability to use the basics of philosophical knowledge, analyze the main stages and patterns of historical development to realize the social significance of their activities;
- the ability to use the basics of economic knowledge in assessing the effectiveness of the results of activities in various spheres;
- ability to communicate orally and in writing in Russian and foreign languages to solve problems of interpersonal and intercultural interaction;
- ability to work in a team, tolerantly accepting social, ethnic, confessional and cultural differences;
- ability to self-organization and self-education;
- ability to use general legal knowledge in various spheres of activity;
- ability to maintain an adequate level of physical fitness to ensure full social and professional activity;
- readiness to use basic methods of protection of production personnel and population from possible consequences of accidents, catastrophes, natural disasters.

*general professional competencies:*

- readiness to use fundamental general engineering knowledge;
- readiness to critically analyze the accumulated experience, to change the profile of one's professional activity if necessary;
- ability to realize the social significance of his/her future profession;
- readiness to combine theory and practice to solve engineering problems;
- ability to apply in practice the principles of rational use of natural resources and environmental protection;
- ability to use normative legal documents in his/her professional activity;
- readiness to choose measuring instruments in accordance with the required accuracy and operating conditions;
- ability to follow metrological norms and rules, fulfill the requirements of national and international standards in the field of professional activity;
- ability to use the principles of quality management system.

*professional competencies*, corresponding to the type(s) of professional activity for which the Bachelor's program is oriented:

*research activities:*

- ability to analyze and synthesize;
- ability to choose research methods, plan and conduct necessary experiments, interpret results and draw conclusions;
- readiness to use physical and mathematical apparatus to solve problems

arising in the course of professional activity;

- readiness to use basic concepts, laws and models of thermodynamics, chemical kinetics, heat and mass transfer;

- ability to choose and apply appropriate methods of modeling physical, chemical and technological processes.

*project and analytical activities:*

- ability to perform technical and economic analysis of projects;

- ability to use the process approach;

- ability to use information tools and technologies in solving problems arising in the course of professional activity;

- readiness to make calculations and draw conclusions when solving engineering problems.

*production and technological activities:*

- ability to implement and adjust technological processes in metallurgy and material processing;

- readiness to identify objects for improvement in engineering and technology;

- ability to select materials for products of various purposes, taking into account operational requirements and environmental protection;

- readiness to assess risks and determine measures to ensure safety of technological processes.

*design and technology activities:*

- ability to perform elements of projects;

- readiness to use standard software tools in designing;

- ability to justify the choice of equipment for the implementation of technological processes.

*additional competencies in the field of organizational and management activities agreed with employers:*

- ability to apply methods of technical and economic analysis;

- readiness to use the principles of production management and personnel management;

- readiness to use organizational and legal bases of managerial and entrepreneurial activity;

- ability to organize the work of the team to achieve the set goal.

*additional general professional competencies (APCs) focused on knowledge areas: communication, individual and teamwork, lifelong learning, additional engineering skills:*

- ability to acquire new, expand and deepen previously acquired knowledge, skills and competencies in various areas of life necessary for successful realization in the field of professional activity, including at the intersection of different areas of activity and fields of sciences.

*Special requirements for graduation on this OP:*

- the student should have a general idea of the thesis topic/research plans, and contact potential supervisors one year prior to expected graduation;

- a review meeting is held one year prior to expected graduation to introduce

the student to potential supervisors and to expedite the student's selection of thesis/project topics;

- in order to collect the necessary data and study the actual tasks, methods and procedures on the topic of the thesis, the student undergoes an industrial practice;

- upon completion of the internship, the student shall contact the supervisor in writing or orally and report the results of the work, but not more than one week after the beginning of the 4th year of study;

- within 4 weeks of the start of the placement, the student and supervisor must discuss and decide on the type (research, project or independent study) and topic of the thesis. This is an extremely important discussion and decision, as it is impossible to change the topic and type of work any further;

- the topic of the thesis (project) and the supervisor are assigned to a student or a group of students no more than six weeks after the beginning of the final year of study and is approved by the order of the rector of the higher education institution.

## 4. Passport of the educational program

### 4.1. General information

№	Field name	Note
1	Code and classification of the field of education	6B07 - Engineering, manufacturing and construction industries
2	Code and classification of areas of study	6B072 - Manufacturing and processing industries
3	Group of educational programs	B071 - "Mining and extraction of minerals"
4	Name of the educational program	Metallurgy of non-ferrous metals
5	Brief description of the educational program	is aimed at preparing graduates to carry out research, production-technological, design-analytical and design-technological types of professional activities in various areas of metallurgy and includes analysis and implementation of technological processes, operation and design of equipment in various areas of metallurgical production.
6	Purpose of the OP	training of competitive personnel with critical thinking, fundamental and applied knowledge, research skills in the field of non-ferrous metals metallurgy, capable of making complex and effective decisions in the processing of mineral raw materials from concentrates to metals and their compounds.
7	Type of OP	New
8	NQF level	Level 6 - higher education and practical experience
9	ORC level	Level 6 - a wide range of specialized (theoretical and practical) knowledge (including innovative knowledge). Independent search, analysis and evaluation of professional information
10	Distinctive features of the EP	no
11	List of competencies of the educational program:	Professional Competencies; Research Competencies; Basic competencies and knowledge; Communicative competencies; General competencies; Cognitive competencies; Creative competences; Information and communication competencies.
12	Learning outcomes of the educational program:	LO1 - practicing knowledge of Kazakh, Russian and foreign languages to solve problems arising in the course of professional activity; LO2 - demonstrates knowledge of culture, basics of legal system and legislation of the Republic of Kazakhstan; LO3 - demonstrates fundamental knowledge and understanding of basic chemical laws in metallurgical processes; LO4 - implements and corrects technological processes in

		<p>metallurgy of non-ferrous metals;  LO5 - applies knowledge of physical and mathematical apparatus to solve production problems arising in technological processes of non-ferrous metals metallurgy;  LO6 - performs professional function in the field of metallurgy, using methods of mathematical analysis and modeling, theoretical and experimental research;  LO7 - applies in practice the principles of rational use of natural resources;  LO 8 - justifies the choice of equipment for the implementation of technological processes;  LO9 - applies applied software tools and modern methods of information processing in the sphere of professional activity;  LO10 - applies experimental computational methods to solve various practice-oriented assignments of a research nature;  LO11 - applies appropriate methods of modeling physical, chemical and technological processes in the field of metallurgy;  LO12 - Demonstrates knowledge in the field of scientific and technological innovation, skills and abilities to search, evaluate, select information.</p>
13	Form of training	Full-time full-time
14	Term of study	4 years
15	Loan volume	240
16	Languages of instruction	Kazakh/Russian
17	Academic degree awarded	Bachelor of Engineering and Technology
18	Developer(s) and authors:	Barmenshinova M.B. Dzhumankulova S.K.

## 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	Amount of credits	Formed learning outcomes (codes)											
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10	LO11	LO12
Cycle of general education disciplines															
Required component															
1	Foreign language	After determining the level (according to the results of diagnostic testing or IELTS results), students are assigned to groups and disciplines. The name of the discipline corresponds to the level of English language proficiency. When moving from level to level, the prerequisites and post-requisites of the disciplines are observed.	10	V											
2	Kazakh language (Russian)	The course covers socio-political, socio-cultural spheres of communication and functional styles of the modern Kazakh (Russian) language. The course highlights the specifics of scientific style in order to develop and activate students' professional-communicative skills and abilities. The course allows students to practically master the basics of scientific style and develops the ability to produce structural and semantic analysis of the text.	10	V											
3	Physical Culture	The purpose of the discipline is to master the forms and methods of forming a healthy lifestyle within the system of professional education. Familiarization with the natural-scientific bases of physical education, mastery of modern health-improving technologies, basic methods of independent physical training and sports. And also within the framework of the course the student will master the rules of refereeing in all kinds of sports.	8	V											
4	Information and Communication Technologies (in English)	The task of studying the discipline is to acquire theoretical knowledge about information processes, new information technologies, local and global networks of computers, methods of information protection; to obtain skills in using text editors and table processors; to create databases and various categories of application programs.	5				V								
5	Modern history of Kazakhstan	The course studies historical events, phenomena, facts, processes that took place on the territory of Kazakhstan from ancient times to the present day. The sections of the discipline include: introduction to the history of Kazakhstan; steppe empire of Turks; early feudal states on the territory of	5		V										

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		Kazakhstan; Kazakhstan during the Mongol conquest (XIII century); medieval states in XIV-XV centuries. Also considered are the main stages of formation of Kazakh statehood: the era of the Kazakh Khanate XV-XVIII centuries. Kazakhstan in the Russian Empire; Kazakhstan in the period of civil confrontation and under the totalitarian system; Kazakhstan during the Great Patriotic War; Kazakhstan in the period of independence and at the present stage.													
6	Philosophy	Philosophy shapes and develops critical and creative thinking, worldview and culture, provides knowledge about the most general and fundamental problems of existence and endows them with the methodology for solving various theoretical and practical issues. Philosophy broadens the horizon of vision of the modern world, shapes citizenship and patriotism, contributes to the education of self-esteem, realizes the value of human existence. It teaches to think and act correctly, develops skills of practical and cognitive activity, helps to seek and find ways and means of living in harmony with oneself, society and the world around.	5				V								
7	Module of socio-political knowledge (sociology, political science)	The aim of the course: the formation of theoretical knowledge about society as an integral system, its structural elements, links and relations between them, the features of their functioning and development, as well as political socialization of students of technical university, providing the political aspect of training a highly qualified specialist on the basis of modern world and domestic political thought. Tasks of mastering the discipline: study of basic values of social and political culture and readiness to rely on them in their personal, professional and general cultural development; study and understanding of the laws of development of society and the ability to operate with this knowledge in professional activities; ability to analyze social and political problems, processes, etc.; the ability to analyze social and political problems, processes, etc.; the ability to analyze the laws of development of society.	3				V								
8	Module of socio-political knowledge (culturology, psychology)	It is intended to familiarize students with the cultural achievements of mankind, to understand and assimilate the basic forms and universal laws of formation and development of culture, to develop in them the desire and skills of independent comprehension of the wealth of values of world	3				V								

НАО «КАЗАХСКИЙ НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ  
имени К.И. САТПАЕВА»

		culture for self-improvement and professional growth. During the course of cultural studies the student will consider the general problems of the theory of culture, the leading cultural concepts, universal regularities and mechanisms of formation and development of culture, the main historical stages of formation and development of Kazakhstani culture, its most important achievements. During the study of the course students acquire theoretical knowledge, practical skills and abilities forming their professional orientation from the position of psychological aspects.													
<b>Cycle of general education disciplines</b> <b>Component of choice</b>															
9	Fundamentals of anti-corruption culture and law	The course introduces students to the improvement of socio-economic relations of Kazakhstan society, psychological peculiarities of corrupt behavior. Special attention is paid to the formation of anti-corruption culture, responsibility for corrupt acts in various currents. The purpose of studying the discipline "Fundamentals of anti-corruption culture and law" is to increase public and individual legal awareness and protection culture of students, as well as mechanisms of knowledge system and civic position to counteract corruption as an anti-social phenomenon. Expected results: to realize the values of moral consciousness and follow moral norms in everyday practice; to work on raising the level of moral and legal culture; to use spiritual and moral mechanisms to prevent corruption.	5			V									
10	Fundamentals of Economics and Entrepreneurship	The discipline studies the basics of economics and entrepreneurship from the point of view of science and law; peculiarities, problematic aspects and development prospects; practice and practice of entrepreneurship as a system of economic and organizational relations of business structures; entrepreneurs' readiness for innovative sensitivity. The discipline reveals the content of entrepreneurial activity, career stages, qualification, competence and responsibility of entrepreneurs, theoretical and practical business planning and economic expertise of business ideas, as well as analyzing the risks of innovative development, development of new technologies and technological solutions.	5			V									
11	Fundamentals of scientific research	The purpose of the discipline Fundamentals of Scientific Research Methods is to support students' skills and abilities	5			V									

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	methods	in the field of methodology of scientific cognition. Brief description of the discipline. Methodological foundations of scientific cognition. The concept of scientific knowledge. Methods of theoretical and empirical research. The choice of the direction of scientific research. Stages of research work. Research topic and its relevance. Classification, types and tasks of experiment. Metrological support of experimental research. Computational experiment. Methods of processing the results of the experiment. Formalization of research results. Presentation of research work.													
12	Ecology and life safety	The discipline examines the objectives of ecology as a science, environmental terms, laws of economic development and safety aspects of the work environment. Environmental monitoring and management in the field of its safety. Sources of pollution of atmospheric air, above-ground, underground water, land and ways of solving environmental problems; safety of life in the technosphere; occurrence of situations of natural and man-made character	5			V									
<b>Cycle of basic disciplines University component</b>															
13	Mathematics I	The course is designed to study the basic concepts of higher mathematics and its applications. The main provisions of disciplines used in the study of all general engineering and special disciplines taught by graduate departments. The course sections include elements of linear algebra and analytic theory, introduction to analysis, differential calculus of functions of one and several procedures. Questions, methods of system solutions, and applications of vector calculus to problems in theory, mechanics, and physics are considered. Analytic geometry in the plane and in space, differential calculus of functions of one variable, derivative and differentials, study of functions of behavior, gradient and gradient derivative, extremum of a function of several criteria.	5	V											
14	Mathematics II	The discipline is a continuation of Mathematics I. The course sections include integral calculus of functions of one variable and several functions, series theory. Indefinite integrals, their properties and how to calculate them. Definite integrals and their applications. Non-unique integrals. Theory of numerical series, theory of series definition, control and McLorean series, application of series to approximate calculations.	5		V										

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15	Physics	The course studies the basic physical phenomena and laws of classical and modern physics; methods of physical research; influence as physics, the science of engineering development; the relationship of physics with other sciences and its role in solving scientific and technical problems of the specialty. The course corresponds to the following sections: mechanics, mechanical harmonic waves, basics of molecular-kinetic theory and thermodynamics, electrostatics, direct current, electrogenetism, geometrical optics, wave properties of light, laws of thermal radiation, photoelectric effect.	5	V											
16	Engineering and computer graphics	The course develops in students the following skills: to depict all possible combinations of geometric forms on the plane, to make studies and their measurements, allowing image transformations; to create technical drawings, which are the main and reliable means of information, providing communication between the designer and the designer, technologist, builder. Familiarizes students with the basics of automated preparation of the graphical part of design documents in the AutoCAD environment.	5	V											
17	General chemistry	The aim of the discipline is to study the basic concepts and laws of chemistry; fundamental laws of chemical thermodynamics and kinetics; quantum-mechanical theory of atom structure and chemical bonding. Solutions and their types, redox processes, coordination compounds: formation, stability and properties. Structure of matter and chemistry of elements.	5		V										
18	Physical chemistry	To form in students: the ability to understand the physical and chemical essence of processes and use the basic laws of physical chemistry in complex production and technological activities. After mastering this discipline the student should know: the laws of thermodynamics; basic equations of chemical thermodynamics; methods of thermodynamic description of chemical and phase equilibria in multicomponent systems; properties of solutions; basics of electrochemistry; basic concepts, theories and laws of chemical kinetics and catalysis.	5				V								
19	Technological mineralogy	General information about mineralogy. Formation of minerals in nature. Basic concepts of crystals. Properties of minerals and their classification. Properties of minerals used in processing of various mineral raw materials to obtain metals are studied. Concepts of minerals and deposits.	4			V									

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		Deposits of minerals of the Republic of Kazakhstan.													
20	Fundamentals of mineral processing	Processes of preparation of mineral raw materials for enrichment, basic regularities used in their realization, processes of separation of minerals on the basis of contrasting physical and physical-chemical properties, laws of physics and chemistry underlying these processes, auxiliary processes realized in technologies of enrichment of solid minerals, designs of apparatuses used in various stages of technologies of processing of mineral raw materials, technologies of treatment of waste water and storage of wastes of enrichment factories, control over the quality of enrichment of minerals.	6				V								
21	General metallurgy	This course is an introduction to metallurgy and helps the student learn the basic terms and definitions in metallurgy, general principles of process design, and the design and operating principles of basic metallurgical units.	5					V							
22	Theory of metallurgical processes I	Theory of pyro-, hydro- and electrometallurgical processes: basic regularities, kinetics and thermodynamics of reactions, and properties of metallurgical melts. Such processes as liquation, recrystallization, distillation, rectification, dissolution, extraction, ion exchange, cementation and precipitation of metals and oxides from solutions by gases, etc. are described.	5					V							
23	Metallurgical Process Theory II	Theory of liquation methods of metal refining, evaporation, sublimation, condensation and sublimation processes, properties of oxide and sulfide melts, thermodynamics and kinetics of metal oxidation, carbon and oxide reduction processes, physicochemical bases of sulfide processing. Thermodynamics and kinetics of leaching, extraction and sorption processes.	5					V							
24	Metallurgy of heavy non-ferrous metals	Technological and theoretical foundations of metallurgical processes of copper, nickel, lead and zinc production. Properties of these metals and their compounds, preparation of raw materials for metallurgical processing. Pyrometallurgical and hydrometallurgical methods of processing: roasting, smelting conversion, fire refining, leaching, solution purification, electrolysis and their hardware design. Methods of processing of industrial products and new technologies to improve the complexity of use in the metallurgy of heavy non-ferrous metals.	5				V								
25	Metallurgy of noble	Properties and applications of noble metals and their	5					V							

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	metals	compounds. Sources of raw materials and history of development of noble metals (gold and silver) mining. Types of ores, minerals, enrichment and preparation of raw materials for metallurgical processing. Theoretical basis and practice of processes of opening (decomposition) of minerals of primary and alluvial ores and extraction of noble metals from them. Refining of noble metals. Apparatus design of the main processes. Methods of associated extraction of noble metals from industrial products and wastes of metallurgical production. New technologies in the metallurgy of noble metals.													
26	Metallurgical heat engineering	Technical Thermodynamics. Introduction to metallurgical heat engineering. Heat generation due to chemical energy of fuel and electricity. Basic provisions of the theory of heat transfer. Heat transfer by conduction. Heat transfer by convection. Heat transfer by radiation. Mechanics of liquids and gases. Fundamentals of the theory of similarity and modeling. Fundamentals of general furnace theory. Thermal operation and construction of kilns and drying furnaces. Smelting and foundry furnaces. Refractory materials. Energy equipment. Utilization of secondary energy resources.	5			V									
27	Metallurgical Engineering (in English)	Composition and properties of the gas phase. Thermodynamics of metallurgical processes. Theory of dissociation and strength of chemical compounds. Structure and properties of oxide and metallic melts. Fundamentals of interaction of metallic and oxide phases. Kinetics of processes. Preparation of raw materials for metallurgical process. Classification of metals. Metallurgy of ferrous metals. Production of pig iron and steel. Metallurgy of non-ferrous metals. Hydrometallurgy. Pyrometallurgy. Metallurgical calculations	5					V							
28	Metallurgy of light metals	Methods of stripping ores, concentrates, industrial products containing light metals. Processing of light metal compounds by hydro- and pyrometallurgical methods of concentration, separation to obtain pure compounds and their further processing by rectification, electrolysis, thermal processes.	5												
29	Organization and planning of experiment	Methodological foundations of scientific cognition and creativity; organization and conduct of experimental research. Methods of theoretical and empirical level of research. Processing and analysis of data, their registration in the report. Technique of working with literature. Technique	4												

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		of laboratory experiment. Familiarization with the processes and apparatus for experimental work. Checking the reproducibility of experiments. Methods of processing the results of the experiment. Fundamentals and methods of planning an experiment. Planning of the experiment of the first order and full, fractional factor experiments. Optimization. Gradient method of experiment planning. The essence of the simplex planning method.													
30	Heat power engineering of metallurgical processes	Basic concepts and definitions of the working body and its main parameters, analysis of the fundamental laws of thermodynamics, thermodynamic processes, differential equations of thermodynamics, flow and throttling of gases and vapors. Reciprocal conversion of heat into work, the relationship between thermal, mechanical and chemical processes that take place in thermal and cooling mechanisms. Heat generation due to chemical energy of fuel and electricity. Basic provisions of the theory of heat transfer.	5						V						
<b>Cycle of basic disciplines Elective component</b>															
31	Fundamentals of complex processing of polymetallic raw materials	Non-ferrous metallurgy of the Republic of Kazakhstan is characterized by a variety of raw materials, complex technological schemes, large volumes of technogenic materials, which must be effectively processed with the extraction of valuable components.	5					V							
32	Geotechnologies in metallurgy	Geochemical processes in the Earth's crust. Formation of minerals and deposits of non-ferrous and ferrous metals. By methods of geotechnology. Possibilities of metal extraction by geotechnological methods. Selection of the method of geotechnological extraction of metals in accordance with the nature and condition of ore reserves. Underground, borehole and group leaching. Influence of the nature of the reagent on metal recovery.	5					V							
33	Special electrometallurgy	Basic laws of theoretical and applied electrochemistry. Technological fundamentals of electrorefining and electrodeposition of non-ferrous metals in aqueous and molten media, electroplating the surface of products, as well as the production of metal powders under electrolysis conditions.	5						V						
34	Technology of composite materials	Definition and classification of composite materials. Basic concepts of mechanics of composite materials: modulus of elasticity, strength, fracture, chemical, thermal and	5						V						

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		mechanical stability. Components used in the production of composite materials: matrix and reinforcing materials and their obtaining.													
35	Autogenous processes in metallurgy	Issues of theory and practice of modern autogenous processes of processing of non-ferrous metal raw materials (KIVCET, PZHV, Outokumpu-Ou, QSL, Ausmelt, Isasmelt, etc.). Technological schemes of productions, designs and principle of operation of metallurgical units, basic technical and economic indicators of processes.	5						V						
36	Powder metallurgy	Classification of methods of obtaining powder materials. Mechanical methods of obtaining powder materials. Reducers used in powder metallurgy. Obtaining powders by methods of reduction of chemical compounds of metals. Examples of obtaining powder metals by methods of high-temperature reduction of chemical compounds. Obtaining powder materials by reduction from solutions.	5						V						
37	Dust collection and gas purification in non-ferrous metallurgy	The course "Dust collection and purification of gases in non-ferrous metallurgy" examines the processes occurring in various gas cleaning devices, the design of dust collectors, conditions and features of their operation, as well as methods of their calculation. The schemes used for purification of gases from dust and harmful gaseous components in various shops of ferrous and non-ferrous metallurgy enterprises are studied.	6						V						
38	Metallurgical furnaces	The main types of fuel and its combustion, classification and general characteristics of furnace operation, materials used in furnace construction, the course program provided for the study of elements and designs of a number of furnaces used in non-ferrous and ferrous metallurgy.	6						V						
<b>Cycle of specialized disciplines</b> <b>University component</b>															
39	Metallurgy of rare and disseminated metals	The concept of "rare metals", technical classification of these metals. The position of rare earth metals in the periodic table of elements Mendeleev and features of the technology of obtaining rare metals. Physical and chemical properties, areas of application, sources of raw materials of rare metals. The main processes of processing of raw materials containing rare metals, with the production of finished products in the form of chemical compounds or pure metals. Physico-chemical bases and technology of production of dispersed rare metals (rhenium, selenium, tellurium, germanium, gallium, indium,	4						V						

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		thallium), characterized physical and chemical properties, areas of application of these metals. Methods of production of chemical compounds of diffuse metals from ore and secondary raw materials, the use of liquid extraction and ion-exchange resins in solution processing schemes, issues of integrated use of raw materials are considered. Methods of metal recovery from various compounds and production of compact metals by smelting and powder metallurgy methods are covered and compared.													
40	Alloys of non-ferrous metals	Basic processes of melting of non-ferrous metal alloys includes theoretical, technological and constructive questions in the field of traditional and new metallurgy processes. Acquisition of competencies in analyzing metal production technologies, developing technological schemes and designs of metallurgical units and carrying out technological calculations.	5							V					
41	Metallurgy of secondary raw materials	Basic processes and operations in hydrometallurgy. Theoretical bases and technological schemes of leaching processes. Thermodynamics and kinetics of leaching processes. Oxidation-free and oxidative leaching of metallurgical raw materials. Hydro- and electrometallurgical processing of sulfide materials. Theory and practice of extraction and sorption processes. Fundamentals of precipitation processes of poorly soluble compounds. Fundamentals of hydro- and electrometallurgical processes. Thermodynamics of electrochemical processes in the processing of metallurgical raw materials and obtaining metals.	5							V					
42	Modern environmental schemes and forecasting in metallurgy	Main factors of metallurgy impact on the environment. Consumption of primary and secondary resources. Saving of materials and energy. General principles of creation of ecologically clean metallurgy and requirements to it. Formation of ecological strategy at full cycle plants. Classification of man-made resources. Payment for environmental pollution. Assessment of ecological damage. Ecological and economic efficiency. Main tasks, objects, methods and classification of environmental monitoring system. Environmental management system. Environmental certification. Basic provisions of the series of standards and certification for compliance with ISO 14000 standards.	6							V					
<b>Cycle of specialized disciplines</b>															

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Optional component														
43	Processes and apparatuses in non-ferrous metallurgy	Physico-chemical basis and technology of production of non-ferrous metals from ore and secondary raw materials. Characteristics of raw materials, methods of charge preparation, pyro- and hydrometallurgical processing. Equipment, technical and economic indicators of modern metallurgical processes. Integrated use of raw materials, environmental protection, prospects for the development of metallurgy.	5							V				
44	Theory and practice of metal refining	Methods of separation, concentration and purification of metals (extraction, ion exchange, electrolysis and electrodialysis, crystallization from solutions and melts, purification and separation of metals by methods of vacuum and gas-phase metallurgy, etc.), instrumentation of technological processes, engineering methods of calculation of metal purification.	5							V				
45	Processes of processing of anthropogenic wastes	Methods of processing of technogenic raw materials of some heavy non-ferrous, noble, light and rare metals. Modern pyro- and hydrometallurgical methods of processing technogenic wastes, basic technological schemes and apparatus design of processes of production of basic heavy, rare, light and noble metals from lump waste, slags, dusts, sludge, industrial solutions.	4							V				
46	Corrosion and protection of metals	Interaction of metals with the environment around them, about the mechanism of this interaction; to teach the use of physical and chemical regularities to predict the corrosion resistance of metals, to apply appropriate methods of protection. Classification of corrosion processes. Films on metals. Diffusion mechanism in protective films. Electrochemical corrosion. Thermodynamics of electrochemical corrosion. Secondary processes and products of electrochemical. Classification of protection methods. Methods of protection against chemical and electrochemical corrosion.	4							V				
47	Copper and nickel metallurgy	Technological schemes and processes of processing raw materials containing copper, nickel and other related valuable components; theoretical bases of technological processes of metal production; designs of metallurgical units and principles of their operation, mode parameters and indicators.	6								V			
48	Production of special-purpose alloys	Features of technologies for obtaining pure refractory metals. Trends in the development of refractory metals metallurgy in	6								V			

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		the XXI century. Prospects of application of refractory metals. Production of refractory metal-based alloys by direct synthesis and reduction methods. Production of refractory metal-based alloys by methods of vapor deposition, electrolysis and plasma. Theoretical bases of mechanical alloying processes. Organization and course of mechanical alloying process. Influence of reagents controlling the process. Technology of foundry alloys. Preparation of sintered materials and alloys.													
49	Metallurgy of lead and zinc	Technological schemes and physicochemical basis of processes of lead and zinc production from ores, concentrates and industrial products. Modern pyro- and hydrometallurgical methods of lead and zinc production, basic technological schemes and hardware design of the processes of production of these metals. Processes of preparation of raw materials for metallurgical processing, processes of reductive smelting in shaft furnaces, roasting processes, leaching, cleaning solutions from impurities, fire refining, electrolytic refining in aqueous media to obtain commercial lead and zinc.	5								V				
50	Modern principles of resource and energy saving in rare metals metallurgy	Basics of modern transformations of resource and energy saving in metallurgy of rare metals: lithium, beryllium, gallium; refractory metals: vanadium, titanium, molybdenum, tungsten occur. Fundamentals of resource-saving complex processing of rare and refractory rare metals. Integrated processing of ingredients and wastes of production of rare and refractory rare metals. Principles of energy saving. The choice of technological scheme allows for the integrated use of natural resources, refractory rare metals taking into account environmental requirements.	5								V				
51	Fundamentals of metallurgical production design	The concept and idea of design of industrial facilities, development and/or preparation of design and estimate documentation for the construction of subjects of new and/or changes to existing metallurgical facilities during their expansion, modernization, technical re-equipment, reconstruction, restoration, overhaul, conservation and postutilization. Design of metallurgical facilities should be carried out taking into account the provisions of current legislation and state regulations in the field of architectural, urban planning and construction activities.	5									V			
52	Technology of refractory	Classification of refractory materials. Raw materials for	5									V			

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	and heat-insulating materials	production. Refractory products. Principle scheme of production and structure of refractories. Structure of refractories. Working properties of refractory materials: refractoriness, gas permeability, dimensional constancy, heat resistance, chemical resistance and slag resistance. Physical properties of refractories: thermal expansion coefficient, heat capacity, thermal conductivity, electrical conductivity. Characteristics of some refractory materials (silica, aluminosilicate, fireclay, high alumina, magnesia-based and others).													
53	Recycling technologies in heavy non-ferrous metals metallurgy	Secondary raw materials of heavy non-ferrous metals. Preparation of secondary raw materials of heavy non-ferrous metals for metallurgical processing. Fundamentals and methods of pyro- and hydrometallurgical processing of secondary raw materials of heavy non-ferrous metals. Apparatus design of obtaining secondary heavy non-ferrous metals. Technology of processing waste and secondary raw materials of lead, copper, zinc, nickel. Auxiliary processes in the production of secondary heavy non-ferrous metals. Ecological and economic aspects of production of secondary heavy non-ferrous metals.	5										V		
54	Recycling metallurgy and product design	Processes and technologies of the 2nd process - refining of rough metals, production of steel and alloys, methods of metal scrap processing; processes and technologies of the 3rd process - metal pressure treatment in order to obtain metal products of a given design; processes and technologies of the 4th process - additional processing of rolled products; production of metalware; processing of secondary slags, as well as methods of modern design with the use of 3D-modeling of products.	5										V		
55	Metallurgy of small metals (Cd, Co, Bi, etc.)	This course "Metallurgy of Small Metals" (Cd, Co, Bi, etc.) helps the student to master the basic physical and chemical laws in the processes of metallurgy of small metals and obtaining small metals by pyro- and hydrometallurgical methods.	4											V	
56	New technologies in metallurgy	Chloride and autoclave-reduction methods of lead production. Autoclave processing of low-grade zinc concentrates. The newest production technologies also affect its alloys. New metallothermic and electrochemical processes for titanium production. Bioleaching of copper-containing raw materials, solvent extraction technology, electrolysis	4											V	

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		(SX/EW). Extraction and sorption methods of metal extraction. Off-domain methods of ferrous metals extraction.													
57	Modeling of metallurgical processes	The concept of models and simulation, systems and their characteristics. Theories and similarity criterion for modeling processes. Methods of identification. Methods of development of information databases. Visualization and animation of models.	5												V
58	Metallurgical systems research	Current state and development of physicochemical methods of research of metallurgical systems and processes; methods of measuring temperatures, viscosity, density, electrical conductivity and surface tension of melts, measurement of vapor pressure of metals and their compounds, methods of quality control of metal products; basics of thermodynamic and kinetic analysis of pyrometallurgical and hydrometallurgical processes	5												V

## 5. Curriculum of the educational program

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



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

Educational program 6B07219 - "Metallurgy of non-ferrous metals"  
Group of educational programs B171 - "Metallurgy"

Form of study: full-time Duration of study: 4 years Academic degree: Bachelor of Engineering and Technology

Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	classroom volume of lek/lab /pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters							
								I course		II course		III course		IV course	
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester	7 semester	8 semester
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)															
M-1. Module of language training															
LNG108	English language	GED, RC	10	300	0/0/6	210	E	5	5						
LNG104	Kazakh (Russian) language	GED, RC	10	300	0/0/6	210	E	5	5						
M-2. Module of physical training															
KFK101-104	Physical Culture	GED, RC	8	240	0/0/8	120	Difcreditt	2	2	2	2				
M-3. Module of information technology															
CSE677	Information and communication technologies (in English)	GED, RC	5	150	2/1/0	105	E				5				
M-4. Module of socio-cultural development															
HUM137	History of Kazakhstan	GED, RC	5	150	1/0/2	105	SE		5						
HUM132	Philosophy	GED, RC	5	150	1/0/2	105	E				5				
HUM120	Socio-political knowledge module (sociology, politology)	GED, RC	3	90	1/0/1	60	E				3				
HUM134	Socio-political knowledge module (culturology, psychology)		5	150	2/0/1	105	E			5					
M-5. Module of anti-corruption culture, ecology and life safety base															
HUM136	The base of anti-corruption culture and law	GED, CCH	5	150	2/0/1	105	E			5					
MNG489	Fundamentals of economics and entrepreneurship														
HPP128	Fundamentals of research methods														
CHE656	Ecology and life safety														
CYCLE OF BASIC DISCIPLINES (BD)															
M-6. Module of physical and mathematical training															
MAT101	Mathematics I	BD, UC	5	150	1/0/2	105	E	5							
PHY468	Physics	BD, UC	5	150	1/1/1	105	E	5							
MAT102	Mathematics II	BD, UC	5	150	1/0/2	105	E		5						
M-7. Module of basic training															
GEN429	Engineering and computer graphics	BD, UC	5	150	1/0/2	105	E	5							

CHE495	Chemistry	BD, UC	5	150	1/1/1	105	E		5							
CHE127	Physical chemistry	BD, UC	5	150	1/1/1	105	E			5						
MET514	Fundamentals of complex processing of polymetallic raw materials	BD, CCH	5	150	2/0/1	105	E				5					
MET657	Geotechnology in metallurgy				2/0/1											
MET518	Special electrometallurgy				2/0/1											
MET611	Technology of composite materials	BD, CCH	5	150	2/0/1	105	E					5				
MET652	Autogenous processes in metallurgy	BD, CCH	5	150	2/0/1	105	E					5				
MET599	Powder metallurgy				2/0/1											
MET653	Dust collection and gas cleaning in non-ferrous metallurgy	BD, CCH	6	180	2/0/2	120	E							6		
MET612	Metallurgical furnaces				2/0/2											
AAP179	Educational practice	BD, UC	2		0/0/2				2							
<b>M-8. Basic training module in metallurgy</b>																
MET501	Technological mineralogy	BD, UC	4	120	2/1/0	75	E	4								
MET163	Basics of mineral deposits milling	BD, UC	6	180	2/1/1	120	E			6						
MET500	General metallurgy	BD, UC	5	150	2/0/1	105	E			5						
MET619	Theory of metallurgical processes I	BD, UC	5	150	2/1/0	105	E			5						
MET503	Metallurgy of heavy non-ferrous metals	BD, UC	5	150	2/1/0	105	E				5					
MET596	Theory of metallurgical processes II	BD, UC	5	150	2/1/0	105	E				5					
MET510	Metallurgy of precious metals	BD, UC	5	150	2/0/1	105	E					5				
MET620	Metallurgical heat engineering	BD, UC	5	150	2/1/0	105	E					5				
MET621	Metallurgical engineering (in English)	BD, UC	5	150	2/0/1	105	E					5				
MET654	Metallurgy of light metals	BD, UC	5	150	2/1/0	105	E					5				
MET658	Organization and planning of experiment	BD, UC	4	120	2/0/1	75	E					4				
MET622	Heat engineering of metallurgical processes	BD, UC	5	150	2/0/1	105	E						5			
<b>CYCLE OF PROFILE DISCIPLINES (PD)</b>																
<b>M-9. Module of professional activity in metallurgy</b>																
MET655	Metallurgy of rare and dispersed metals	PD, UC	4	120	2/0/1	75	E						4			
MET656	Non-ferrous metal alloys	PD, UC	5	150	2/0/1	105	E							5		
MET508	Metallurgy of secondary raw materials	PD, UC	5	150	2/1/0	105	E							5		
MET498	Modern ecological schemes and forecasting in metallurgy	PD, UC	6	180	2/0/2	120	E							6		
<b>M-10. Professional activity module</b>																
MET524	Processes and devices in non-ferrous metallurgy	PD, CCH	5	150	2/0/1	105	E						5			
MET497	Theory and practice of metal refining				2/1/0											
MET456	Processes of processing of technogenic waste	PD, CCH	4	120	2/0/1	75	E						4			
MET659	Corrosion and protection of metals				2/1/0											
MET194	Copper and nickel metallurgy	PD, CCH	6	180	2/1/1	120	E							6		
MET422	Production of special alloys				2/0/2											

MET529	Metallurgy of lead and zinc	PD, CCH	5	150	2/1/0	105	E								5	
MET692	Modern principles of resource and energy saving in metallurgy of rare metals				2/0/1											
MET575	Fundamentals of metallurgical production design	PD, CCH	5	150	2/0/1	105	E									5
MET594	Technology of refractory and heat-insulating materials				2/0/1											
MET545	Recycling technologies in heavy non-ferrous metals metallurgy	PD, CCH	5	150	2/1/0	105	E									5
MET582	Advanced metallurgy and product design				2/0/1											
MET455	Metallurgy of small metals (Cd, Co, Bi, etc.)	PD, CCH	4	120	2/0/1	75	E									4
MET697	New technologies in metallurgy				2/0/1											
AAP143	Production practice I	PD, UC	2		0/0/2						2					
AAP183	Production practice II	PD, UC	3		0/0/3									3		
M-11. Module of "R&D"																
MET558	Modelling of metallurgical processes	PD, CCH	5	150	2/0/1	105	E									5
MET583	Metallurgical systems research				2/1/0											
M-12. Module of final attestation																
ECA108	Final examination	FA	8													8
M-13. Module of additional types of training																
AAP500	Military affairs	ATT	0													
Total based on UNIVERSITY:								31	29	28	32	29	31	33	27	
								60		60		60		60		

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
		required component (RC)	university component (UC)	component of choice (CCH)	Total
GED	Cycle of general education disciplines	51		5	56
BD	Cycle of basic disciplines		91	21	176
PD	Cycle of profile disciplines		25	39	
<b>Total for theoretical training:</b>		<b>51</b>	<b>116</b>	<b>65</b>	<b>232</b>
FA	Final attestation	8			8
<b>TOTAL:</b>		<b>59</b>	<b>116</b>	<b>65</b>	<b>240</b>

Decision of the Academic Council of KazNRTU named after K.Satpayev. Protocol №5, 24.11.2022 y.

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Protocol №3, 17.11.2022 y.

Decision of the Academic Council of MaMI named after O. Baikonurov. Protocol №3, 15.11.2022 y.

Vice-Rector for Academic Affairs

B.A. Zhautikov

Director of the Mining and Metallurgical Institute named

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

Representative of the employers' council of the LLP "Kazakhmys"

E.A. Ospanov

**6. Additional educational programs (Minor)**

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