



**SATBAYEV
UNIVERSITY**

**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**

EDUCATIONAL PROGRAM

6B07203 - Metallurgy and mineral processing

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 «6B07203 – Metallurgy and mineral processing» was approved at a meeting of the Academic Council of KazNITU 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 "6B07203 – Metallurgy and mineral processing" was developed by the academic committee in the direction of «Manufacturing and processing industries»








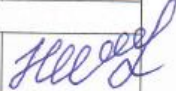
FULL NAME	Academic degree/ academic title	Job title	Place of work	Signature
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Chepushtanova T.A.	PhD doctor c.t.s.	Head of the Department of MPHEaTSM	KazNITU named after K.I. Satpaeva	
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Employers:				
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	

Table of contents

- List of abbreviations and designations
- 1. Description of the educational program
- 2. The purpose and objectives of the educational program
- 3. Requirements for the evaluation of learning outcomes of the educational program
- 4. Passport of the educational program
 - 4.1. General information
 - 4.2. The relationship between the achievability of the formed learning outcomes according to the educational program and academic disciplines
- 5. Curriculum of the educational program
- 6. Additional educational programs (Minor)

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 the implementation of specialized bachelor's degree training in the educational program «6B07203 – Metallurgy and mineral processing» at Satbayev University and was developed within the framework of the direction «Manufacturing and processing industries».

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

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

- Law of the Republic of Kazakhstan “On amendments and additions to certain legislative acts of the Republic of Kazakhstan on the issues of expanding the 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 October 30, 2018 No. 595 “On Approval of the Model Rules for the Activities of Educational Organizations of the Relevant Types”;

- State obligatory standard of higher education (Appendix 7 to the order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018 No. 604;

- Decree of the Government of the Republic of Kazakhstan dated 19.01.12 No. 111 “On approval of the Model Rules for Admission to Education in Educational Organizations Implementing Educational Programs of Higher Education” with amendments and additions dated 07.14.16 No. 405;

- Decree 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”;

- Decree of the Government of the Republic of Kazakhstan dated December 31, 2019 No. 1050 “On Approval of the State Program for Industrial and Innovative Development of the Republic of Kazakhstan for 2020-2025”;

- “National Qualifications Framework”, approved by the protocol dated June 16, 2016, by the Republican Tripartite Commission on Social Partnership and Regulation of Social and Labor Relations;

- Sectoral qualifications framework "Mining and metallurgical complex" dated July 30, 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, December 14, 2012;

- “New opportunities for development in the conditions of the fourth industrial revolution”. Message of the President of the Republic of Kazakhstan N. Nazarbayev to the people of Kazakhstan. 01/10/2018;

– “The Third Modernization of Kazakhstan: Global Competitiveness”.
Message of the President of the Republic of Kazakhstan N.Nazarbayev to the
people of Kazakhstan. 01/31/2017

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 deep training of specialists in narrowly focused specialization, has led to the emergence of interdisciplinary barriers and hindering the development of new "growth points" that are located at the junctions of disciplines.

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

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

The program is comprehensive and knowledge-intensive. The effectiveness of the use of 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 activities in high-tech sectors of the economy of the Republic of Kazakhstan on the basis of the development of priority areas of science and technology, the development of high-tech industries, competitive technologies in the processing of man-made raw materials and waste.

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

The benefits of the Program are:

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

The training of specialists provides training in the main areas, each of which includes modern fundamental content necessary for the training of highly qualified specialists in demand by the economy of the republic.

The educational program "Metallurgy and mineral processing" is based on the specialties "Metallurgy" and "Mineral processing" and includes fundamental, natural science, general engineering and professional training of bachelors in the field of metallurgy and enrichment in accordance with the development of science and technology, as well as the changing needs of mining -metallurgical industry. A distinctive feature of the program is that the program makes the graduate adaptable to the manufacturing sector, due to the content in the educational program of 40% of general engineering disciplines. A graduate receives a fundamental set of general engineering disciplines, as well as a maximum set of profile disciplines. The program provides an in-depth study of the theory of concentrating and metallurgical processes, metallurgical heat engineering, the theory of furnaces, the design and design of metallurgical units, physical and chemical methods of analysis, software for calculating physical and chemical processes, technological processes for obtaining powder, composite materials and coatings of high quality and increased consumer properties. Graduates have knowledge of the technology of metallurgical production of ferrous, non-ferrous, noble, radioactive, rare and other metals.

The mission of the educational program is to train bachelors-metallurgists and concentrators who know the mineral resource base, enrichment technologies of ore and technogenic raw materials, production technologies and areas of consumption of metals, who have fundamental training in physics, mathematics,

chemistry, physical and chemical foundations of enrichment technologies and metallurgy, processing metals and alloys, production of composite materials and nanomaterials. Providing students with knowledge, skills and abilities that allow them to analyze problems in the field of professional activity and find ways to solve them, solve engineering problems of designing technologies and equipment of plants and factories, conduct experimental research using information technology and mathematical modeling.

Area of professional activity. Specialists who have completed a bachelor's degree perform production, technological and organizational work at industrial enterprises, as well as carry out research work on the enrichment of minerals, the production of ferrous, non-ferrous, rare and radioactive metals, alloys and special materials; processing of metals and alloys; heat treatment of metals and alloys.

Objects of professional activity. The objects of professional activity of graduates are enrichment factories, enterprises of ferrous and non-ferrous metallurgy, chemical, mining and chemical and machine-building industries, branch research and design institutes, factory laboratories, secondary vocational and higher educational institutions.

The subjects of professional activity are the technological processes of the mining and processing and metallurgical industries, the processing of raw materials and the production of metal products with increased consumer properties, technologies for the production and processing of metals and materials, the study of the structure and properties, equipment for mining and metallurgical production, automatic control systems for metallurgical production and quality control end products.

Types of economic activity: screener, batcher, crusher, concentrator, mill operator, washing machine operator, calciner, enrichment products controller, thickener operator, filter operator, equipment maintenance and repair technician, unit repairman, control panel operator, dryer, flotation machine, mineralogical analysis laboratory assistant; moulder, process engineer, converter loading operator, converter steelmaker, smelter, metallurgical technician, molten salt electrolyzer, hydrometallurgical operator, metal and alloy smelter, powder metallurgy equipment designer, new metal designer, eco-recycler in metallurgy, equipment supervisor.

2. Purpose and objectives of the educational program

The purpose of EP «6B07203 - Metallurgy and mineral processing» is:

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

The objectives of the EP «6B07203 - Metallurgy and mineral processing» are:

– combining the efforts of the university and industrial enterprises in conducting scientific research, training and retraining of personnel in the field of studying the principles and patterns of functioning and development of cities and megacities, the features of anthropogenic impacts on objects of the urban environment, the principles of sustainable development of urban areas and measures of their organizational and legal support with ensuring the true interdisciplinarity of education in these areas;

– formation of skills and abilities for choosing and evaluating methods of protecting the environment from anthropogenic impact in urban areas;

– strengthening the technological component of classical natural science education, to give knowledge on modern technologies, without lowering the bar of the level of fundamental education;

– fundamentals for the development and implementation of fundamental and applied research and development in the field of geological exploration and mineral processing, mining and metallurgy using new advances in technology, new generation technology and environmental monitoring 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, the experimental base for the implementation of educational research, laboratory and term papers, industrial and undergraduate practice;

– raising the level of educational and methodological work by creating new curricula, textbooks, teaching and methodological aids, including on electronic media;

– providing 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 high technology innovative companies and other research centers;

– organization of effective interaction with foreign universities for the development of educational standards of a new generation, the implementation of student exchange, the training and retraining of specialists in the mining and metallurgical industry in specialized bachelor's programs;

– implementation of international cooperation in the development of new technologies in the mining and metallurgical industry through the implementation of joint contracts, participation in international conferences, organization of

international exchange of employees, students and young scientists with specialized universities and laboratories of the world, international scientific and educational organizations;

- the formation of theoretical and practical knowledge in the technologies for processing technogenic and secondary raw materials, knowledge in the technologies for the production of ferrous and non-ferrous metals, as well as their alloys and various metal-containing products from technogenic materials and secondary resources.

- formation of theoretical and practical knowledge in the field of processing of critical raw materials and metals, innovative "green" technologies of the metallurgical sector, recycling of metallurgical production waste and environmental restoration.

The modern educational program allows you to specialize in:

- *secondary metallurgy* - an industry that allows you to extract all known metals by processing technogenic raw materials and using secondary resources. The graduate has the ability to analyze raw materials and apply the best method for extracting metals from man-made and secondary raw materials; apply the technologies of pyro-, hydro-, electrometallurgy; with their knowledge and skills can influence the reduction of waste and environmental pollution; influence the optimal fuel consumption, the ability to perform the necessary technical, heat engineering, heat power, metallurgical calculations; carry out the design of workshops and equipment for secondary metallurgy.

- *physical metallurgy* - a branch that provides skills and studies the physical state of metals, their properties, the effects of various media, stress and pressure; testing of metals for compliance with quality and safety standards; perform various kinds of analytical, physico-chemical methods of analysis.

- *technological metallurgy* - an industry where metal parts are designed and the processes in which they are formed are controlled, the graduate has the skills of casting, forging, welding, rolling, etc.

- recycling of metal-containing waste - an industry that allows you to create an environmentally friendly production, with a fairly complete use of production waste and the subsequent restoration of renewable natural resources, reducing environmental pollution, ensuring the integrated use of raw materials, environmental protection, resource and energy saving and waste disposal.

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

B - basic knowledge, skills and abilities

B1 - know the history of the Republic of Kazakhstan, the stages and prospects for the development of the state;

B2 - the ability to use modern technologies to access and exchange information sources. Have the skills to work on a computer as a means of managing, storing and processing information and performing calculations using general and applied software products.

B3 - to speak state, Russian and one of the most common foreign languages in the industry at a level that ensures human communication.

B4 - be able to use fundamental general engineering knowledge, the ability to practically use the basics and methods of mathematics, physics and chemistry in their professional activities.

B5 - the ability to use the knowledge and methods of general engineering disciplines (basics of automation and mechanics) in practical activities.

B6 - awareness in the field of financial analysis and project evaluation, project management and business, in the basics of macro- and microeconomics, knowledge and understanding of risks in market conditions.

B7 - familiarization with technological processes and skills in working at metallurgical enterprises.

B8 - know and own the main business processes in an industrial enterprise.

B9 - know the basics of military training and be able to work with military equipment.

P - professional competencies, including in accordance with the requirements of industry professional standards

P1 - a wide range of theoretical and practical knowledge in the professional field;

P2 - possession of professional terminology and the ability to work with educational and scientific materials in the specialty in the original in the state, Russian and foreign languages. The ability to logically correctly, argue, and clearly build oral and written speech in three languages

P3 - knowledge of the requirements of the Rules of safety and labor protection at work and the ability to use them in practice.

P4 - possession of a culture of professional safety; the ability to identify hazards and assess risks in their field; possession of the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters and improving working conditions in the field of professional activity.

P5 - willingness to apply professional knowledge to prevent and minimize negative environmental impacts in production.

P6 - the ability to use regulatory legal documents in their activities.

P7 - choose rational methods for the production and processing of ferrous and non-ferrous metals that meet the requirements of integrated technology, economics and ecology.

P8 - be able to realize the social significance of their future profession. Possess knowledge of the formation and development of the mining and processing and metallurgical industry of Kazakhstan and modern priority trends

P9 - be able to combine problem theory and practice to solve engineering problems, carry out balance heat engineering, hydraulic, aerodynamic calculations of metallurgical processes and apparatus, based on practical data.

P10 - be able to apply in practice the principles of rational use of natural resources and environmental protection.

P11 - be able to choose measuring instruments in accordance with the required accuracy and operating conditions.

P12 - be able to implement and adjust technological processes in metallurgy.

P13 - be able to identify objects for improvement in engineering and technology.

P14 - the ability to identify concentrating and metallurgical apparatuses and systems for transporting melts (reagents, slurries, etc.) that have a low efficiency, an increased level of danger, and determine the necessary measures to improve equipment and / or production technology.

P15 - be able to apply the methods of technical and economic analysis. Calculate and analyze chemical and physico-chemical processes, mass transfer processes occurring in the technological processes of processing (enrichment) of mineral raw materials, production and processing of ferrous and non-ferrous metals.

P16 - be able to choose research methods, plan and conduct the necessary experiments, interpret the results and draw conclusions.

P17 - to calculate and analyze the processes of fuel combustion and heat release, external and internal heat transfer in furnaces for various technological purposes, to choose rational temperature and thermal modes of operation of metallurgical furnaces. Calculate and analyze hydrometallurgical processes and apparatuses, choose the optimal technological regimes.

P18 - have the ability to analyze and synthesize. Conduct literary and analytical reviews.

P19 - be able to use the basic concepts, laws and models of thermodynamics, chemical kinetics, heat and mass transfer. Be able to select and apply appropriate methods for modeling physical, chemical and technological processes.

P20 - be able to carry out elements of projects.

P21 - independently perform: calculations of pyro- and hydrometallurgical equipment; drawings of parts and structural elements; strength and stiffness calculations; calculations of parts of machines and mechanisms; choose electrical equipment and calculate its operating modes; offer an automation system for the main equipment.

P22 - be able to justify the choice of equipment for the implementation of technological processes.

P23 - conduct a feasibility study of the metallurgical process. Plan the volume of production and perform cost calculations for the production and sale of products, determine the break-even conditions. Carry out approximate calculations of harmful emissions and assessment of the ecological state of existing and planned technological processes and units.

P24 - independence: implementation of independent work in typical situations and under guidance in difficult situations of professional activity; independent organization of training. Responsibility: for the results of work; for your own safety and the safety of others; for meeting environmental and fire safety requirements. Complexity: solving typical practical problems; choice of a method of action from known ones based on knowledge and practical experience: maintaining the main technological process in accordance with their area of professional activity.

O - universal, social and ethical competencies

O1 - in work and everyday life, show respect for the environment.

O2 - take into account ethical and legal norms in interpersonal communication, knowledge and understanding of their rights and obligations as a citizen of the Republic of Kazakhstan.

O3 - the ability to critically generalize, analyze and perceive socio-political information using the basic laws of the development of society in solving social and professional problems, the ability to analyze socially significant problems and processes in society. Own the culture and logic of thinking, understanding the general laws of the development of society and the ability to analyze them.

O4 - awareness of the need and the acquisition of the ability to independently learn and improve their skills throughout their careers.

O5 - understanding and practical use of healthy lifestyle norms, including prevention issues to improve performance

O6 - the ability to build interpersonal relationships and work in a group (team).

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 the problem, argumentation of conclusions and competent handling of information;

C2 - independence: executive and managerial activities for the implementation of tasks under the leadership, providing for the independent definition of tasks, organization and control of the implementation of its subordinate employees. Responsibility: for the results in the implementation of the norm; for your own safety and the safety of others; for meeting environmental and fire safety requirements. Complexity: solving various typical practical tasks that require independent analysis of work situations: Maintaining the main technological process in the field of one's professional activity, of various levels of complexity, mentoring in a team. Quality control of semi-finished products, technological processes and finished products.

C3 - independence: management activities within the framework of the

technological process section and the strategy of the enterprise. Responsibility: for the evaluation and improvement of one's own work, one's own training and the training of others; for your own safety and the safety of others; for meeting environmental and fire safety requirements.

Complexity: solving practical problems based on the choice of solutions in various changing conditions of working situations: Conducting work on organizing the technological process of production of the mining and metallurgical industry of design, carrying out work on the development and implementation of new equipment, technologies and assortment, organizational and managerial work to improve quality production and production efficiency of the mining and metallurgical industry.

C4 - independence: management activities within the framework of the enterprise's activity strategy, involving the coordination of work with other areas. Responsibility: for planning and developing processes of activity that can lead to significant changes or development, responsibility for improving the professionalism of employees. Complexity: activities aimed at solving problems involving the choice and variety of solutions. Carrying out research and experimental work, designing the expansion and modernization of production, expanding and updating the range of the mining and metallurgical industry, introducing new technologies.

Description of general mandatory standard requirements for graduation from the university and the award of the academic degree of bachelor: the development of at least 240 academic credits of theoretical training and the final thesis.

Special requirements for graduating from a university in this EP:

- the student must have a general idea of the topic of the thesis / research plans, and contact potential supervisors one year before the expected completion of studies;

- in order to get acquainted with potential supervisors and speed up the choice of topics for the thesis (project) by students, a review meeting is held one year before the expected completion of studies;

- to collect the necessary data and study current tasks, methods and procedures on the topic of the thesis, the student undergoes an internship;

- upon completion of the internship, the student contacts the supervisor in writing or orally and reports on the results of the work, but no more than a week after the start of the 4th year of study;

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

- the topic of the thesis (project) and the supervisor are assigned to the student or group of students no more than six weeks after the start of the graduation year of study and is approved by order of the rector of the higher educational 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 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 bachelors in the field of metallurgy and mineral processing in accordance with the development of science and technology, as well as the changing needs of the mining and metallurgical and mining and processing industries.
6	Purpose of the EP	Training of competitive personnel with critical thinking, fundamental and applied knowledge, research skills in the field of metallurgy and mineral processing, capable of making comprehensive and effective decisions in the processing of mineral raw materials from concentrates to metals and their compounds
7	EP type	New
8	NQF level	Level 6 - higher education and practical experience
9	ORC level	Level 6 - a wide range of special (theoretical and practical) knowledge (including innovative). 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; Communication competencies; Universal competencies; Cognitive competencies; Creative competencies; Information and communication competencies.
12	Learning outcomes of the educational program:	LO1 - communicate successfully and at a high level in business circles in the state and other foreign languages; are able to use the physical and mathematical apparatus to solve problems arising in the course of professional activity; know traditions and culture, the basics of the legal system and legislation of the Republic of Kazakhstan; know the basics of the theory of fundamental sections of chemistry; are able to implement and adjust technological processes in metallurgy and enrichment.

		<p>LO2 - use language skills in the professional sphere; use the basic laws of natural science disciplines in professional activity, apply methods of mathematical analysis and modeling, theoretical and experimental research.</p> <p>LO3 - have the skills to handle modern technology, are able to use information technology in the field of professional activity; possess the basic methods, methods and means of obtaining, storing, processing information; are able to apply in practice the principles of rational use of natural resources.</p> <p>LO4 - have basic knowledge in the field of natural sciences that contribute to the formation of a highly educated person with a broad outlook and culture; are able to combine theory and practice to solve engineering problems; are able to use basic concepts, laws and models of thermodynamics, chemical kinetics, heat and mass transfer.</p> <p>LO5 - are able to justify the choice of equipment for the implementation of technological processes; are able to apply applied software and modern methods of information processing.</p> <p>LO6 - possess basic concepts and laws, laws and theories, as well as modern technologies for explaining and using knowledge in enrichment and metallurgical processes; apply experimental calculation methods to solve various practice-oriented tasks of a scientific, laboratory and educational nature.</p> <p>LO7 - possess knowledge in the field of scientific and technical innovation, skills and abilities of searching, evaluating, selecting information; possess methods of recording and processing experimental results; possess methods of selecting material for theoretical classes and laboratory work on enrichment and metallurgy.</p> <p>LO8 - are able to identify objects for improvement in engineering and technology; are able to use standard software tools in design; are able to choose and apply appropriate methods of modeling physical, chemical and technological processes in the field of enrichment and metallurgy.</p>
13	Form of study	full-time
14	Training period	4 years
15	Volume of loans	240
16	Languages of instruction	Kazakh/Russian
17	Awarded Academic Degree	Bachelor of Engineering and Technology
18	Developer(s) and authors:	Barmenshinova M.B. Chepushtanova T.A.

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
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 divided into groups and disciplines. The name of the discipline corresponds to the level of English proficiency. When moving from level to level, prerequisites and postrequisites of disciplines are observed.	10	V							
2	Kazakh (Russian) language	The socio-political, socio-cultural spheres of communication and functional styles of the modern Kazakh (Russian) language are considered. The course covers the specifics of the scientific style in order to develop and activate professional communication skills and abilities of students. The course allows students to practically master the basics of the scientific style and develop the ability to produce a 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 framework of the vocational education system. Acquaintance with the natural-scientific foundations of physical education, possession of modern health technologies, the main methods of independent physical education and sports. And also within the framework of the course, the student will master the rules of refereeing in all 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 computer networks, methods of information protection; obtaining skills in the use of text editors and spreadsheet processors; creation of 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; the steppe empire of the Turks; early feudal states on the territory of Kazakhstan; Kazakhstan during the Mongol conquest (XIII century); medieval states in the XIV-XV centuries. The main stages of the formation of Kazakh statehood are also considered: the era of the Kazakh Khanate of the XV-XVIII centuries. Kazakhstan within the Russian Empire; Kazakhstan in the	5		V						

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		period of civil confrontation and in the conditions of a totalitarian system; Kazakhstan during the Great Patriotic War; Kazakhstan in the period of formation of independence and at the present stage.									
6	Philosophy	Philosophy forms and develops critical and creative thinking, worldview and culture, provides knowledge about the most general and fundamental problems of being and endows them with a methodology for solving various theoretical practical issues. Philosophy expands the horizon of vision of the modern world, forms citizenship and patriotism, contributes to the education of self-esteem, awareness of the value of human existence. It teaches to think and act correctly, develops the skills of practical and cognitive activity, helps to seek and find ways and means of life in harmony with oneself, society, and the world around.	5				V				
7	Module of socio-political knowledge (sociology, political science)	The purpose of the course: the formation of theoretical knowledge about society as an integral system, its structural elements, connections and relationships between them, the features of their functioning and development, as well as the political socialization of students of a technical university, ensuring the political aspect of training a highly qualified specialist based on modern world and domestic political thought. The tasks of mastering the discipline: the study of the basic values of social and political culture and the willingness 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 this knowledge in professional activities; the ability to analyze social and political problems, processes, etc.	3				V				
8	Module of socio-political knowledge (culturology, psychology)	It is designed to acquaint students with the cultural achievements of mankind, to understand and assimilate the basic forms and universal patterns of the formation and development of culture, to develop their desire and skills to independently comprehend the entire wealth of values of world 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, leading cultural concepts, universal patterns and mechanisms for the formation and development of culture, the main historical stages of the formation and development of Kazakhstani culture, its most important achievements. In the course of studying the course, students acquire theoretical knowledge, practical skills and abilities, forming their professional orientation from the standpoint of psychological aspects.	3				V				
Cycle of general education disciplines											

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Selectable Component											
9	Fundamentals of anti-corruption culture and law	The course introduces students to the improvement of socio-economic relations of Kazakhstan society, psychological features of corrupt behavior. Special attention is paid to the formation of an anti-corruption culture, responsibility for corruption 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 protect the culture of students, as well as the mechanisms of the knowledge system and citizenship to combat corruption as an antisocial phenomenon. Expected results: to realize the values of moral consciousness and follow moral norms in everyday practice; to work on improving 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 fundamentals of economics and entrepreneurship from the point of view of science and law; features, problematic aspects and development prospects; the practice and practice of entrepreneurship as a system of economic and organizational relations of business structures; the willingness of entrepreneurs to innovative receptivity. The discipline reveals the content of entrepreneurial activity, career stages, qualifications, competence and responsibility of entrepreneurs, theoretical and practical business planning and economic expertise of business ideas, as well as risk analysis of innovative development, development of new technologies and technological solutions.	5			V					
11	Fundamentals of scientific research methods	The purpose of the discipline Fundamentals of Scientific Research Methods is to support students' skills and abilities in the field of methodology of scientific cognition. A brief description of the discipline. Methodological foundations of scientific knowledge. The concept of scientific knowledge. Methods of theoretical and empirical research. Choosing the direction of scientific research. Stages of research work. The research topic and its relevance. Classification, types and tasks of the experiment. Metrological support of experimental studies. Computational experiment. Methods of processing the results of the experiment. Registration of the results of the study. Presentation of a research paper.	5			V					
12	Ecology and life safety	The discipline studies the problems of ecology as a science, environmental terms, laws of economic development and aspects of safety in working conditions. Environmental monitoring and management in the field of its safety. Sources of pollution of atmospheric air, aboveground, underground waters, lands and ways of solving environmental problems; safety of life in the technosphere;									

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named after K.I.SATBAYEV»

		occurrence of natural and man-made situations										
Cycle of basic disciplines University component												
13	Mathematics I	The course is designed to study the basic concepts of higher mathematics and its applications. The main provisions of the 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 analytical theory, an introduction to analysis, differential calculus of functions of one and several procedures. The issues, methods of system solutions, the use of vector calculus for solving problems of theory, mechanics, physics are considered. Analytical geometry on the plane and in space, differential calculus of functions of one variable, derivative and differentials, study of behavior functions, gradient derivative and gradient, extremum of a function of several criteria.	5	V								
14	Mathematics II	The discipline is a continuation of Mathematics I. The sections of the course include integral calculus of functions of one variable and several functions, series theory. Indefinite integrals, their properties and methods of their calculation. Definite integrals and their application. Improper integrals. Numerical series theory, series definition theory, control and Maclaurin series, application of series to approximate calculations.	5		V							
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 technology 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, fundamentals of molecular kinetic theory and thermodynamics, electrostatics, direct current, electrognatism, geometric optics, wave properties of light, laws of thermal radiation, photoelectric effect.	5	V								
16	Engineering and computer graphics	The discipline is aimed at the study of methods for the image of objects and general rules of drawing, using computer graphics; the study of basic concepts and geometric solutions and methodologies for developing applications with a graphical interface; manages the skills of using graphical systems for the development of drawings, using 2D and 3D modeling methods.	5	V								
17	General chemistry	Objective: has knowledge of fundamental issues of general chemistry and skills of their application in professional activity. Summary of laws, theoretical provisions and conclusions that exclude the basics	5		V							

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named after K.I.SATBAYEV»

		of disciplinary proceedings; properties and limitations of the environment based on periodic elements of D.I.Mendeleev's law and modern ideas about the structure of substances; Fundamentals of thermochemical dynamics and kinetics; processes in solutions; structure of complex compounds.									
18	Physical chemistry	The course Physical Chemistry allows students to form the ability to understand the physico-chemical essence of processes and the basic laws of physical chemistry in complex industrial and technological activities. In the course of training, the student studies the laws of thermodynamics; equations of basic chemical thermodynamics; methods of thermodynamic description and phase equilibria in multicomponent components; properties of solutions; fundamentals 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 about crystals. Properties of minerals and their classification. The properties of minerals used in the processing of various mineral raw materials to obtain metals have been studied. The concept of minerals and deposits. Mineral deposits of the Republic of Kazakhstan.	4				V				
20	Fundamentals of mineral processing	The processes of preparation of the mineral component for enrichment, the basic principles used in their implementation, the processes of separation of minerals based on the contrast of physical and physico-chemical properties, the laws of physics and chemistry underlying these processes, auxiliary processes implemented in the technologies of enrichment of organic minerals, apparatus designs, the introduction of various stages of mineral processing technology, technologies of wastewater treatment and waste storage of processing plants, quality control, variable products, research on enrichment.	6				V				
21	Ore preparation processes and equipment	Ore preparation is widely used in the processing of ores of ferrous and non-ferrous metals, rare metal and gold-bearing raw materials, as well as non-metallic raw materials, building materials and other areas of the national economy of the Republic of Kazakhstan. This course studies in detail the technological processes of ore preparation and enrichment, the design of the equipment used, the methods for calculating and selecting the main and auxiliary equipment, the operation of crushing and grinding equipment.	5				V				
22	Gravity enrichment methods	This course studies: Theoretical foundations of gravity enrichment; Processes of hydraulic and pneumatic tuning and equipment; Enrichment in a reliable environment; Enrichment by jigging; Enrichment in a stream of water flowing along an inclined surface;	5				V				

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		Pneumatic enrichment; Ore washing.										
23	General metallurgy	Cast iron and iron production: raw materials and their preparation; blast furnace design; domain process; equipment and operation of sections serving the blast furnace; performance indicators of blast furnaces; methods of non-domain (coke-free) production of iron. Steel production: general principles of steelmaking; converter steel production; open-hearth steel production; steel smelting in electric furnaces; ingots and steel casting; continuous casting of steel; modern technologies for producing high quality steel; out-of-furnace processing of steel; complex technologies for out-of-furnace processing of cast iron and steel; steel production in continuous units; melting processes. Production of non-ferrous metals: copper metallurgy; nickel metallurgy; aluminum metallurgy; receiving other non-ferrous metals.	5					V				
24	Theory of metallurgical processes I	Theory of pyro-, hydro- and electrometallurgical processes: basic laws, kinetics and thermodynamics of reactions, as well as 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				
25	Theory of metallurgical processes II	Theory of liquation methods of metal refining, evaporation, sublimation, condensation and sublimation processes, properties of oxide and sulfide melts, thermodynamics and kinetics of oxidation of metals, carbon and reduction of oxides, physico-chemical bases of sulfide processing. Thermodynamics and kinetics of leaching, extraction and sorption processes.	5					V				
26	Metallurgy of heavy non-ferrous metals	Technological and theoretical foundations of metallurgical processes for the production of copper, nickel, lead and zinc. Properties of these metals and their compounds, preparation of raw materials for metallurgical processing. Pyrometallurgical and hydrometallurgical processing methods: roasting, melting, conversion, fire refining, leaching, purification of solutions, electrolysis and their hardware design. Methods of processing industrial products and new technologies to increase the complexity of the use of heavy non-ferrous metals in metallurgy.	5					V				
27	Metallurgy of precious metals	Properties and scope of noble metals and their compounds. Sources of raw materials and the history of the development of mining of precious metals (gold and silver). Types of ores, minerals, enrichment and preparation of raw materials for metallurgical processing. Theoretical foundations and practice of the processes of opening (decomposition) of minerals of primary and placer ores and	5					V				

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named after K.I.SATBAYEV»

		extraction of precious metals from them. Refining of precious metals. Hardware design of the main processes. Methods for the associated extraction of precious metals from middlings and wastes of metallurgical production. New technologies in the metallurgy of noble metals.									
28	Laboratory and engineering workshop on metallurgical heat engineering	Basic thermodynamic parameters and basic laws of thermodynamics used in metallurgical heat engineering. The subject and tasks of heat exchange. Convective heat transfer (heat transfer). Convection calculations. Thermal conductivity. The basic law of thermal conductivity. Heat transfer by thermal conductivity in stationary mode. Calculations of thermal conductivity. Modeling and experimental study of complex heat transfer. Heat generation. Heat exchange by radiation, calculations. Heat generation due to the chemical energy of fuel and electricity. Technical analysis of fuel. Classification of furnaces. Basic furnace equipment, a workshop on 3D atlases of metallurgical furnaces.	5					V			
29	Thermal power engineering of metallurgical processes	Basic concepts and definitions of the working fluid and its main parameters, analysis of the fundamental laws of thermodynamics, thermodynamic processes, differential equations of thermodynamics, outflow and throttling of gases and vapors. The mutual transformation of heat into work, the relationship between thermal, mechanical and chemical processes that take place in thermal and cooling mechanisms. Heat generation due to the chemical energy of fuel and electricity. Basic provisions of the theory of heat transfer.	4					V			
30	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 metal melts. Fundamentals of the interaction of metallic and oxide phases. Kinetics of processes. Preparation of raw materials for the metallurgical process. Classification of metals. Metallurgy of ferrous metals. Manufacture of iron and steel. Metallurgy of non-ferrous metals. Hydrometallurgy. Pyrometallurgy. Metallurgical calculations	5						V		
Cycle of basic disciplines Optional component											
31	Thermal power engineering of metallurgical processes	Basic concepts and definitions of the working fluid and its basic parameters, analysis of the fundamental laws of thermodynamics, thermodynamic processes, differential equations of thermodynamics, outflow and throttling of gases and vapors. The mutual transformation of heat into work, the relationship between thermal, mechanical and chemical processes that occur in thermal and cooling mechanisms. Heat generation due to the chemical energy of fuel and electricity. The main provisions of the theory of heat transfer.	5			V					

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32	Powder metallurgy	Classification of methods for obtaining powder materials. Mechanical methods for 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 recovery materials from solutions.	5			V					
33	Magnetic and special enrichment methods	Magnetic properties of minerals, Theory of magnetic fields of magnetic separators. Classification of magnetic separators. The structure and dynamics of movement of mineral particles in them. The practice of using magnetic separators and auxiliary devices. Obtaining artificial concentrates from mineral raw materials that cannot be enriched. Combined processes of processing of mineral raw materials (combination of enrichment processes and metallurgical operations). Fine-tuning of substandard concentrates.	5				V				
34	Theory and technology of preparation of technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical processing	Scrap metal as a man-made raw material for metallurgical enterprises. Material and energy saving in the recycling of scrap metal. Technologies for the preparation of ferrous and non-ferrous metals used in metallurgical enterprises. The concept of elements - "vagants". Their influence on the quality of products from ferrous metals and metallurgical technologies. Circulation of "vagrant" in the technological cycle of metallurgical enterprises. Modern standards of the EU, USA and Japan, taking into account the presence of "vagrant" in metallurgical raw materials. Preparation of technogenic energy resources. Plastics, MSW, used oils and lubricants. Methods for the environmentally safe use of technogenic energy resources in metallurgical production.	5				V				
35	Experimental foundations in metallurgy	Formation of knowledge, skills and abilities in the field of metallurgical experiment technology and their application in professional activities. Objectives of the course: to convey basic theoretical knowledge on the course "Metallurgical Laboratory"; to teach how to solve typical tasks for the implementation of a metallurgical experiment; to form students' skills of practical work in the laboratory for research of metallurgical processes and systems.	5					V			
36	Flotation reagents in MP	Basic theories of flotation in its current state. The methods for studying the action of flotation reagents and the mechanism of the flotation process are described in detail, as well as the processing of the results obtained. The fundamentals of the theory and practice of using flotation reagents in the flotation of non-ferrous ores and accompanying rare metals are outlined. The structure and composition, physical and chemical properties of the reagents are described.	5					V			

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named after K.I.SATBAYEV»

37	Special electrometallurgy	Basic laws of theoretical and applied electrochemistry. Technological foundations of electrefining and electrodeposition of non-ferrous metals in aqueous and molten media, electroplating of the surface of products, as well as obtaining metal powders under electrolysis conditions.	5							V		
38	Corrosion and protection of metals	Classification of corrosion processes. Films on metals. Mechanism of diffusion 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.	5							V		
39	Processes and equipment for enrichment production	The course deals with the theoretical foundations of the processes, describes the design of typical devices and methods for their calculation, highlights the issues of servicing the devices.	5							V		
40	Autogenous processes in metallurgy	Issues of theory and practice of modern autogenous processes for the processing of non-ferrous metal raw materials (KIVCET, PZhV, Outokumpu-Ou, QSL, Ausmelt, Isasmelt, etc.). Technological schemes of production, design and principle of operation of metallurgical units, the main technical and economic indicators of processes.	5							V		
41	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 mechanical stability. Components used in the production of composite materials: matrix and reinforcing materials and their preparation.	6								V	
42	Auxiliary facilities in the MP	The discipline studies the theoretical foundations of the processes of dehydration and dust collection, the design and principle of operation of apparatuses used for drainage, centrifugation, thickening, filtering, drying and dust collection. Methods for the selection and calculation of the main auxiliary equipment and dehydration schemes are considered. The relationship of auxiliary facilities with the technological processes of enrichment. Methods of calculations and selection of auxiliary equipment.	6								V	
Cycle of major disciplines University component												
43	Metallurgy of ferrous metals	Raw material base of ferrous metallurgy. Basic minerals, ore quality, supply of iron, manganese, chromium ores to metallurgical enterprises. The main deposits of coal and flux-forming. Preparation of raw materials for melting. Obtaining coke, coke battery. Preparation of ores for smelting. Crushing, separation, enrichment of ores. Production of sinter and pellets. Processes occurring during	5								V	

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

		sintering of sinter and firing of pellets. Cast iron smelting.									
44	Metallurgy of light metals	Methods for opening ores, concentrates, middlings containing light metals. Processing of compounds of light metals by hydro- and pyrometallurgical methods of concentration, separation in order to obtain pure compounds and their further processing by methods of rectification, electrolysis, thermal processes.	5							V	
45	Metallurgy of secondary raw materials	The course "Metallurgy of secondary raw materials" examines the main processes in hydrometallurgy. Theoretical bases and technological schemes of leaching processes. Non-oxidizing and oxidizing 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. Thermodynamics of electrochemical processes in the processing of metallurgical raw materials and the production of metals.	6							V	
46	Flotation enrichment methods	The physical and chemical foundations of the flotation process are considered. Reasons for the appearance of free energy at interphase boundaries. The use of flotation reagents to control the change in energy at the phase boundaries. Adsorption processes at phase separations. Classification of flotation reagents and their role in flotation. The mechanism of action of the reagents. Flotation machines, features of their designs and applications. Flotation enrichment schemes. Brief information about the use of reagents in the flotation enrichment of various types of ores.	4							V	
Cycle of major disciplines Selectable Component											
47	Processes of processing of technogenic waste	The course "Processes of processing technogenic waste" examines the main ways of processing technogenic raw materials of some heavy non-ferrous, noble, light and rare metals. In particular, the main sources of waste generation, their classification and characteristics are considered. Modern schemes are given, the design of the main and auxiliary equipment for the preparation of waste for metallurgical processing is described. Modern pyro- and hydrometallurgical methods of processing man-made waste, basic technological schemes and hardware design of the processes of production of basic heavy, rare, light and precious metals from lump waste, slags, dusts, slurries, industrial solutions and a number of other man-made waste are highlighted.	5						V		
48	Receipt, quality and certification of by-products during recycling	Peculiarities of metallurgical processes during melting "to slag". Blast-furnace melting with the use of technogenic materials and obtaining slag of a given composition. Regularities of mass transfer	5						V		

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

		between metal and slag. Formation of neutral compositions of elements - "vagants". By-products of coke production. The use of finely dispersed carbon-containing man-made materials in the production of coke. Slag processing. Vittrification of potentially hazardous and toxic compounds. Obtaining metallurgical gases of a given composition using technogenic raw materials. Quality and certification of by-products.									
49	Consumer properties of metallurgical products	Classification of metallurgical products, quality control methods, requirements for consumer properties of metallurgical products, fixed in the standardization and certification system, specific consumer properties of metallurgical products obtained from secondary and technogenic raw materials. Methods and technologies used for the process of management and quality control of metallurgical products obtained from secondary and technogenic raw materials	5					V			
50	Geotechnology in metallurgy	Geochemical processes in the earth's crust. Formation of minerals and deposits of non-ferrous and ferrous metals. Methods of geotechnology. Possibilities of extraction of metals by geotechnological methods. Choice of geotechnology method of metal mining in accordance with the nature and condition of the ore reserves. Underground, borehole and group leaching. Influence of the nature of the reagent on the extraction of metals.	5					V			
51	Special and combined enrichment methods	Special methods of enrichment, ore sorting of mineral raw materials (manual and automatic) to improve the quality of raw materials and extract valuable minerals. Mineral raw materials that cannot be enriched and methods for their processing using combined processes (enrichment and metallurgy). Refinement of concentrates that are conditioned in terms of the base metal, but defective in terms of impurities. Processing of collective concentrates obtained by enrichment methods using pyro- and hydrometallurgical operations.	5					V			
52	Geotechnological methods of enrichment	Methods of geotechnological extraction of minerals, in order to determine the possibility of transferring extracted useful components to a mobile state. The issues of physico-chemical bases of technological processes are considered. The schemes of geotechnological processing of uranium, gold, manganese, iron ores and non-metallic minerals are studied, and the processes of processing geotechnical products are also considered.	5					V			
53	Alloys of non-ferrous and ferrous metals	The main processes of melting alloys of non-ferrous and ferrous metals include issues of a theoretical, technological and constructive nature in the field of traditional and new metallurgy processes. Acquisition of competencies in the analysis of metal production technologies, the development of technological schemes and designs	4					V			

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

		of metallurgical units and the conduct of technological calculations.										
54	Design of metallurgical units in ferrous metallurgy	The main advanced designs of melting, heating and thermal furnaces; methods of calculation, design of units and optimization of their technological parameters.	4						V			
55	Processing of uranium and rare metal raw materials of Kazakhstan	Prospects for the use of atomic energy for peaceful purposes, world reserves of uranium, its mineral sources. Properties of uranium, forms of its presence in aqueous solutions. Methods for preparing ores for hydrometallurgical processing. Radiometric and mechanical enrichment of uranium ores, their acid and carbonate leaching. Extraction of uranium from poor and off-balance ores. Chemistry of rare earth elements. Methods for extracting REE from various types of mineral raw materials.	4						V			
56	Theory and practice of metal refining	Methods for the separation, concentration and purification of metals (extraction, ion exchange, electrolysis and electrodialysis, crystallization from solutions and melts, purification and separation of metals by vacuum and gas-phase metallurgy, etc.), instrumentation of technological processes, engineering methods for calculating the purification of metals.	4						V			
57	Testing and control of enrichment processes	Basic concepts about the process of testing minerals, products of their enrichment, control of technological processes at processing plants. List of controlled parameters. Methods and technical means of sampling from immobile materials and from moving masses. Determination of the minimum amount of sample from the mass of the batch being tested. Minimum mass of incremental sample. The minimum mass of a sample for analysis: chemical, granulometric, fractional. Sample preparation. Control of enrichment processes. Technological and commodity balance. Organization of testing and control.	4							V		
58	Ore processing research	Methods of taking technological samples, preparing them for the study of enrichment, drawing up schemes for cutting samples, the material and mineralogical composition of ore using various methods of analysis, the use of planning experiments, the methodology of conducting circuit experiments, the procedure for conducting semi-industrial and industrial tests, the methodology for compiling research reports.	4							V		
59	Processes and apparatuses in ferrous metallurgy	The discipline "Processes and apparatuses in ferrous metallurgy" studies existing and new processes and apparatuses for the production of ferrous metals and their chemical compounds.	6							V		
60	Processes and devices in non-ferrous metallurgy	Theoretical regularities of hydromechanical, thermal and mass transfer processes in metallurgy; hardware design of these processes; production of analysis of technological processes and necessary	6							V		

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named after K.I.SATBAYEV»

		calculations.										
61	Metallurgical furnaces	The main types of fuel and its combustion, classification and general characteristics of the operation of furnaces, materials used in furnace building, elements and design of a number of furnaces used in non-ferrous and ferrous metallurgy.	6							V		
62	Types of coatings on metals and their production processes	Formation of knowledge, skills and abilities in the field of theory and technology of obtaining coatings on metals. Objectives of the course: to transfer the basic theoretical knowledge of the course "Types of coatings on metals and the processes of their production"; to teach to solve typical tasks on the processes of obtaining coatings on metals and methods of quality control; to form students' analytical thinking skills in the field of coating technology, depending on the raw materials used and methods of obtaining coatings on metals.	6							V		
63	Enrichment of gold and uranium ores	Technology for processing gold ores using enrichment and metallurgical operations. Refining. Associated gold recovery during the processing of copper and zinc concentrates. Technologies for processing secondary raw materials containing precious metals. Material composition of uranium ores. Technology for processing uranium ores. Refining. Associated extraction of rare metals during the processing of uranium raw materials.	6							V		
64	Modeling of enrichment processes	Methods for compiling models of enrichment processes. Obtaining high technological indicators by performing experiments using mathematical planning methods. Compilation of planning matrices, evaluation of the dispersion of experiments, determination of the adequacy of the resulting model and its application. General questions of modeling production systems. Application of theoretical relationships and statistical methods for the mathematical description of enrichment processes.	6							V		
65	Dust collection and gas cleaning in non-ferrous metallurgy	Processes occurring in various gas cleaning devices, design of dust collectors (cyclones, filters, scrubbers, etc.), conditions and features of their operation, as well as methods for their calculation. The advantages and disadvantages of each dust collecting device are considered, an analysis of their application areas is given. The schemes used to clean gases from dust and harmful gaseous components in various workshops of ferrous and non-ferrous metallurgy enterprises are being studied.	5							V		
66	Metallurgy of lead and zinc	Technological schemes and physical and chemical bases of the processes of obtaining lead and zinc from ores, concentrates and industrial products. Modern pyro- and hydrometallurgical methods for the production of lead and zinc, the main technological schemes and instrumentation of the production processes of these metals are	5							V		

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named after K.I.SATBAYEV»

		covered. The processes of preparation of raw materials for metallurgical processing, processes of reduction smelting in shaft furnaces, processes of roasting, leaching, purification of solutions from impurities, fire refining, electrolytic refining in aqueous media with the production of commercial lead and zinc are studied. New technologies in the production of lead and zinc are considered.									
67	Heat and mass transfer of metallurgical processes	General information about mass transfer processes, basic concepts and definitions. Methods for expressing phase compositions. balance between phases. Mass transfer equation. Material balances of mass transfer processes. The mechanism of mass transfer processes. The driving force of mass transfer processes. The rate of mass transfer processes. General information about heat exchange processes, basic concepts and definitions. Heat transfer surface, stationary and non-stationary heat transfer processes, methods of heat transfer. Thermal balances. Heat transfer equations.	5							V	
68	Processes and apparatuses of powder metallurgy	Production of metal powders by mechanical methods. Obtaining iron powders by reduction methods. Production of tungsten and molybdenum powders by reduction methods. Carbonyl method for obtaining metal powders.	5							V	
69	Enrichment of polymetallic ores	Ores of non-ferrous metals are a complex raw material and a source of obtaining not only non-ferrous, but also rare, noble, rare earth metals, sulfur, barite, fluorite, quartz, feldspars and other elements, and minerals that are essential for various sectors of the national economy of the Republic of Kazakhstan. The course is devoted to the study of the variety of technological schemes, reagent regimes and methods for the enrichment of polymetallic ores.	5							V	
70	Metallurgy of ferroalloys	Prospects for the development of ferroalloy metallurgy. The essence and classification of electrical methods of heating and melting. The main groups of ferroalloys smelted in ferroalloy shops.	5							V	
71	Ferroalloy metallurgy	Prospects for the development of ferroalloy metallurgy. The essence and classification of electrical methods of heating and melting. The main groups of ferroalloys smelted in ferroalloy shops.	5							V	
72	Metallurgy of copper and nickel	Theoretical foundations of traditional and modern technological processes for the production of copper and nickel. Designs of metallurgical units and principles of their work. Regime parameters and indicators of processes.	5							V	
73	Converting metallurgy and product design	The course "Current metallurgy and product design" considers the processes and technologies of the 2nd stage - refining of ferrous metals, production of steel and alloys, methods of processing scrap metal; processes and technologies of the 3rd redistribution - processing of metals by pressure in order to obtain metal products of	5							V	

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		a given design; processes and technologies of the 4th redistribution - additional processing of rolled products; production of hardware; processing of pig slags, as well as modern design methods using 3D product modeling.									
74	Enrichment of mining and chemical and non-metallic raw materials	The discipline deals with the processing of mining and chemical raw materials, the equipment used, the principles for choosing processing schemes and evaluating technical and economic indicators, analyzing the material and mineralogical composition of the ore to choose the most effective technological scheme for enrichment. General information about mining and chemical raw materials and raw material base is given. Consumer requirements for enrichment products. The current state in the field of enrichment and processing, the prospects for further development of this industry.	5							V	
75	Enrichment of ores of ferrous metals	The material composition of ore raw materials. Theoretical foundations and features of the enrichment of various ores of ferrous metals. Principles and conditions for the separation of ore minerals from intergrowths with non-metallic minerals, dressing of ores and its determination. Classification of methods and processes of ore beneficiation based on separating forces. Schemes and apparatus for enrichment of magnetite, titanomagnetite and other ores of complex composition, oxidation of iron ores and quartzites, brown iron ore, manganese and chromium ores, carbonate iron and manganese ores. Experience in the work of factories for the enrichment of ferrous metal ores. Ways of integrated use of mineral raw materials of ferrous metals.	5							V	
76	Foundry production of metals and alloys	The properties of the most widely used metals and casting alloys are discussed, the conditions and methods for preparing alloys determined by these properties are discussed, the basics of filling a casting mold with a melt are outlined, the regularities of crystallization of alloys under real conditions are considered, the processes of solidification of cast billets and their effect on crystallization and properties of alloys in cast blanks.	5							V	
77	Metallurgy of radioactive and related metals	Issues of a theoretical and applied nature concerning the processing of raw materials containing radioactive elements, as well as the technology for the production of pure radioactive and associated metals, in particular uranium and RMZ.	5								V
78	Production of special purpose alloys	Features of technologies for obtaining pure refractory metals. Trends in the development of metallurgy of refractory metals in the XXI century. Prospects for the use of refractory metals. Preparation of alloys based on refractory metals by direct synthesis and reduction methods. Obtaining alloys based on refractory metals by the methods	5								V

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named after K.I.SATBAYEV»

		of deposition from the gas phase, electrolysis and plasma. Theoretical foundations of mechanical alloying processes. Organization and course of the process of mechanical alloying. Influence of reagents controlling the process. Technology of foundry alloys. Obtaining sintered materials and alloys.									
79	Modern principles of resource and energy conservation in the metallurgy of rare metals	Fundamentals of modern transformations of resource and energy saving in metallurgy of rare metals: lithium, beryllium, gallium; There are refractory metals: vanadium, titanium, molybdenum, tungsten. Fundamentals of resource-saving complex processing of rare and refractory rare metals. Complex processing of ingredients and waste from the production of rare and refractory rare metals. Principles of energy saving. The choice of the technological scheme allows the integrated use of natural resources, refractory rare metals, taking into account environmental requirements.	5								V
80	Dewatering and dust collection	The discipline studies the theoretical foundations of the processes of dehydration and dust collection, the design and principle of operation of apparatuses used for drainage, centrifugation, thickening, filtering, drying and dust collection. Methods for the selection and calculation of the main auxiliary equipment and dehydration schemes are considered.	5								V
81	Design of processing plants	The discipline studies general information about the design and design of mining and metallurgical enterprises, initial data for design, selection and justification of qualitative indicators of enrichment and productivity of factories and individual workshops. Selection and calculation of technological and water-sludge enrichment schemes, selection and calculation of main and auxiliary equipment. Organization of design of buildings and structures, general principles of equipment layout. Repair, storage and tail facilities, master plan. CAD elements in the design of processing plants.	5								V
82	Metallurgy of small metals (Cd, Co, Bi, etc.)	This course "Metallurgy of small metals" (Cd, Co, Vi, etc.) helps the student to master the basic physico-chemical laws in the processes of metallurgy of small metals and the production of small metals by pyro- and hydrometallurgical methods.	4								V
83	New technologies in metallurgy	Chloride and autoclave-reducing methods for the production of lead. Autoclave processing of low-grade zinc concentrates. The latest production technologies also affect its alloys. New metallothermic and electrochemical processes of titanium production. Bio-leaching of copper-containing raw materials, solvent extraction technology, electrolysis (SX/EW). Extraction and sorption methods of metal	4								V

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named after K.I.SATBAYEV»

		extraction. Non-domain methods of obtaining ferrous metals.										
84	Fundamentals of gentle metallurgy	Fundamentals of gentle metallurgy, basic principles and approaches in modern metallurgical processing schemes. Fundamentals of lean metallurgy. Fundamentally new schemes for obtaining metals are based on saving resources and preserving the environment. Modernization of equipment of enterprises, preservation of environmental priorities and resource conservation. Metallurgical, technological schemes for the production of non-ferrous metals, taking into account the balance of ecology, raw materials and energy consumption.	4									V
85	Fundamentals of quality management of metallurgical products	Implementation of resource- and energy-saving, environmentally friendly technologies in metallurgy. The quality of metallurgical products. Activation of work to reduce production costs. Experiment planning. Methods of mathematical modeling and optimization of metallurgical processes. Statistical methods are an effective tool for collecting and analyzing quality information. Standardization and certification of metallurgical products. Integrated management system for quality management at metallurgical enterprises.	4									V
86	Operation and repair of processing equipment	The disciplines study the design and operation of equipment for water supply, air supply, transportation of products at processing plants, bunker farming, storage of raw materials and enrichment of products. The interrelation of auxiliary agriculture with technologies of enrichment processes is considered. The methods of calculation and selection of auxiliary equipment, as well as the structure of the auxiliary economy are studied.	4									V
87	Industrial water supply, transport and tailings facilities of processing plants	Classification of waste. Methods and places of waste storage. Chemical and mineralogical composition of waste. Current and stacked tailings of the processing plant. Methods of processing tailings layers of processing plants (gravity, flotation, special and combined methods). Waste obtained during the enrichment of sulfide, oxidized and other ores. Processing of slag from metallurgical plants. Promising technologies for the processing of solid household waste.	4									V
88	Modeling of metallurgical processes	The concept of models and modeling, systems and their characteristics. Theories and similarity criteria for process modeling. Identification methods. Methods of developing information databases. Visualization and animation of models.	5									V
89	Fundamentals of metallurgical production design	General principles of investment and integrated technological design, characteristics of modern metallurgical workshops, production facilities, enterprises as design objects in their classical, probabilistic, statistical	5									V

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named after K.I.SATBAYEV»

		and cenological visions, methods of project development at the initial pre-project, design and post-project stages, characteristics and principles of layout of all major technological conversions in ferrous and non-ferrous metallurgy										
90	Research of metallurgical systems	The current state and development of physico-chemical methods for the study of metallurgical systems and processes; methods for measuring temperatures, viscosity, density, electrical conductivity and surface tension of melts, measuring vapor pressure of metals and their compounds, methods for quality control of metal products; fundamentals of thermodynamic and kinetic analysis of pyrometallurgical and hydrometallurgical processes	5									V
91	Technology of refractory and thermal insulation materials	Classification of refractory materials. Raw materials for production. Refractory products. Schematic diagram of the production and structure of refractories. The structure of refractories. Working properties of refractory materials: fire resistance, 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, chamotte, high-alumina, magnesia-based and others).	5									V
92	Digitalization of mining and processing and metallurgical plants	The issues of the theory of building digital systems for various levels of production management in the mining and processing and metallurgical industries are presented. The analysis of the structure, functional and supporting parts of digitalization is given, the methodological foundations of building digital technologies are highlighted. Special attention is paid to the role of digital technologies in improving the economic management mechanism in the mining and processing and metallurgical industries, as well as building its information support. Digital technologies will optimize processes with a reduction in the risk of injury to people working in hazardous areas. Complex tasks related to mining (mine development planning, geological modeling, process management and maintenance) can be managed by intelligent analytical software packages and controlled in an integrated way, which will allow making decisions in real time taking into account the entire technological process of the mining industry.	5									V
93	Fundamentals of scientific research in ore dressing	The discipline studies the problems of organizing and staging scientific research, the choice of the topic of scientific work, the stages and content of scientific research, the principles of selecting information on the topic of scientific research, planning and staging an experiment, requirements for publication materials, registration of patent documentation, presentation of scientific results and a report on the	5									V

		topic of research. Acquaintance with the biography of scientists of Kazakhstan and the CIS, the role of scientific research in the formation and development of the enrichment industry.									
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5 Curriculum of the educational program



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



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

CURRICULUM
of Educational Program on enrollment for 2023-2024 academic year
Educational program 6B07203 - "Metallurgy and mineral processing"
Group of educational programs B071 - "Mining and extraction of minerals"

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

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	Difcred it	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						

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

CHE127	Physical chemistry	BD, UC	5	150	1/1/1	105	E				5				
MET513	Theory and technology of steelmaking processes	BD, CCH	5	150	2/0/1	105	E				5				
MET599	Powder metallurgy				2/0/1										
MET516	Magnetic and special enrichment methods				1/1/1										
MET515	Theory and technology of preparation of technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical processing	BD, CCH	5	150	2/1/0	105	E					5			
MET609	Experimental Foundations in Metallurgy				2/1/0										
MET517	Flotation reagents in mineral processing				2/1/0										
MET518	Special electrometallurgy	BD, CCH	5	150	2/0/1	105	E					5			
MET610	Corrosion and protection of metals				2/1/0										
MET521	Processes and devices of processing production				2/1/0										
MET127	Autogenous processes in metallurgy	BD, CCH	6	180	2/0/2	120	E						6		
MET122	Technology of composite materials				2/1/1										
MET420	Auxiliary economy in mineral processing				2/0/2										
AAP179	Educational practice	BD, UC	2		0/0/2				2						
M-8. Basic training module for ore dressing															
MET501	Technological mineralogy	BD, UC	4	120	2/1/0	75	E	4							
MET163	Basics of mineral processing	BD, UC	6	180	2/1/1	120	E			6					
MET502	Processes of ore preparation and equipment	BD, UC	5	150	2/1/0	105	E				5				
MET505	Gravitational methods of enrichment	BD, UC	5	150	2/1/0	105	E					5			
M-9. Basic training module in metallurgy															
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					
MET596	Theory of metallurgical processes II	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				
MET510	Metallurgy of precious metals	BD, UC	5	150	2/0/1	105	E					5			
MET689	Laboratory and engineering workshop of metallurgical heat engineering	BD, UC	6	180	2/1/1	120	E					6			
MET622	Heat power engineering of metallurgical processes	BD, UC	5	120	2/0/1	75	E						5		
MET621	Metallurgical Engineering (in English)	BD, UC	5	150	2/0/1	105	E						5		
CYCLE OF PROFILE DISCIPLINES (PD)															
M-10. Module of professional activity in metallurgy															
MET509	Metallurgy of ferrous metals	PD, UC	5	150	2/0/1	105	E							5	
MET504	Metallurgy of light metals	PD, UC	5	150	2/1/0	105	E							5	
MET415	Metallurgy of secondary raw materials	PD, UC	6	180	2/1/1	120	E							6	
M-11. Module of professional activity on ore dressing															
MET507	Flotation methods of dressing	PD, UC	4	120	2/1/0	75	E						4		

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named after K.I.SATBAYEV»

M-12. Professional activity module													
MET554	Processes of processing of technogenic waste	PD, CCH	5	150	2/0/1	105	E					5	
MET555	Receive, the quality and certification of by-products in the process of recycling				2/0/1								
MET590	Consumer properties of metallurgical products				2/0/1								
MET591	Geotechnology in metallurgy				2/0/1								
MET571	Special and combined methods of dressing				1/1/1								
MET542	Geotechnological methods of enriching				1/1/1								
MET528	Alloys of non-ferrous and ferrous metals	PD, CCH	4	120	2/0/1	75	E					4	
MET573	Design of metallurgical units in ferrous metallurgy				2/0/1								
MET592	Processing of uranium and rare metal raw materials of Kazakhstan				2/0/1								
MET617	Theory and practice of metal refining				2/1/0								
MET560	Assay and control of concentrating processes				1/1/1								
MET574	Ore beneficiation research				2/1/0								
MET141	Processes and devices in the ferrous metallurgy	PD, CCH	6	180	2/0/2	120	E					6	
MET140	Processes and devices in non-ferrous metallurgy				2/0/2								
MET108	Metallurgical furnaces				2/1/1								
MET489	Types of coatings on metals and their production processes				2/0/2								
MET417	Enrichment of gold-bearing and uranium ores				2/0/2								
MET156	Modeling of enrichment processes				2/1/1								
MET563	Dust collection and gas cleaning in non-ferrous metallurgy	PD, CCH	5	150	2/0/1	105	E					5	
MET529	Metallurgy of lead and zinc				2/1/0								
MET580	Heat and mass transfer of metallurgical processes				2/0/1								
MET581	Processes and devices of powder metallurgy				2/0/1								
MET531	Enrichment of polymetallic ores				1/1/1								
MET532	Enrichment of rare metal ores				2/1/0								
MET533	Metallurgy of ferroalloys	PD, CCH	5	150	2/0/1	105	E					5	
MET534	Metallurgy of copper and nickel				2/1/0								
MET582	Advanced metallurgy and product design				2/0/1								
MET536	Enrichment of mining and chemical and non-metallic raw materials				2/1/0								
MET537	Concentration of ferrous metals ores				1/1/1								
MET538	Foundry production of metals and alloys	PD, CCH	5	150	2/0/1	105	E					5	
MET539	Metallurgy of radioactive and related metals				2/0/1								
MET584	Production of special alloys				2/0/1								
MET692	Modern principles of resource and energy saving in metallurgy of rare metals				2/0/1								
MET541	Enrichment of ores of ferrous metals				1/1/1								
MET564	Design of concentrating factory				2/1/0								
MET455	Metallurgy of small metals (Cd, Co, Bi, etc.)				2/0/1								
MET697	New technologies in metallurgy				2/0/1								

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

MET693	Fundamentals of gentle metallurgy	PD, CCH	4	120	2/0/1	75	E										4
MET694	Fundamentals of quality management of metallurgical products				2/0/1												
MET546	Exploitation and repair of concentrating equipment				1/1/1												
MET453	Industrial water supply, transport and tailings of concentrating factories				2/0/1												
AAP143	Production practice I	PD, UC	2		0/0/2							2					
AAP110	Production practice II	PD, UC	1		0/0/1											1	
M-13. Module of "R&D"																	
MET558	Modeling of metallurgical processes	PD, CCH	5	150	2/0/1	105	E										5
MET575	Fundamentals of metallurgical production design				2/0/1												
MET583	Metallurgical systems research				2/1/0												
MET594	Technology of refractory and heat-insulating materials				2/0/1												
MET576	Digitalization of mining and processing and metallurgical plants				2/1/0												
MET572	Fundamentals of scientific research in ore dressing				2/1/0												
M-14. Module of final attestation																	
ECA108	Final examination	FA	8														8
M-15. Module of additional types of training																	
AAP500	Military affairs	ATT	0														
Total based on UNIVERSITY:								31	29	28	32	31	29	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		83	31	176
PD	Cycle of profile disciplines		23	39	
	Total for theoretical training:	51	106	75	232
FA	Final attestation	8			8
	TOTAL:	59	106	75	240

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 after

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

E.A. Ospanov

Representative of the employers' council of the LLP "KAZ Minerals"

U.K. Jetybaeva

U.K. Jetybaeva

6. Additional educational programs (Minor)

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