



**Mining and Metallurgical Institute named after O.A. Baikonurov**

**Department of Metallurgy and Mineral Processing**

**EDUCATIONAL PROGRAM**

**6B07213 – «Mineral Processing»**

Code and classification of the field of education:	6B07 – Engineering, manufacturing and construction industries
Code and classification of training areas:	6B072 – Manufacturing and processing industries
Group of educational programs:	In 071 - Mining and mining
The level of the NRK:	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
Срок обучения:	4 years
Объем кредитов:	240

**Almaty, 2022**

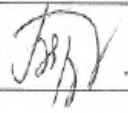



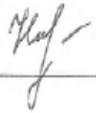
The educational program "6B07213 – Mineral Processing" was approved at a meeting of the Academic Council of KazNITU named after K.I.Satpayev.

Protocol No. 13 from "28" 04 2022 y.

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

Protocol no. 4 from "26" 09 2022 y.

The educational program "6B07213 – Mineral Processing" was developed by the academic committee in the direction of " Production and processing industries"

Full name	Academic degree/ academic title	Post	Place of work	Signature
<b>Chairman of the Academic Committee:</b>				
Barmenshinova M.B.	c.t.s	Head of the department	KazNTU named after K.I. Satpayev	
<b>Teaching staff:</b>				
Dyussenova S.B.,	PhD	Assistant Professor	KazNTU named after K.I. Satpayev	
<b>Employers:</b>				
Jetybaeva U.K.	-	Chief metallurgist	LLP "KAZ Minerals"	
Arinov A.K.	-	General manager	Goldstone Minerals LLP	
<b>Students</b>				
Turymbai N.D.	-	4th year student	KazNTU named after K.I. Satpayev	

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### List of abbreviations and designations

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

**GOSO** – The State compulsory standard of education of the Republic of Kazakhstan;

**MES RK** – Ministry of Education and Science of the Republic of Kazakhstan;

**OP** – educational program;

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

**SROP** – independent work of a student with a teacher (independent work of a student (undergraduate, doctoral student) with a teacher);

**RUP** – working curriculum;

**QED** – catalog of elective disciplines;

**VK** – university component;

**KV** – component of choice;

**NRK** – National Qualifications Framework;

**ORC** – Industry qualifications framework;

**RO** – learning outcomes;

**CC** – key competencies.

## 1. Description of the educational program

It is intended for the implementation of specialized training of bachelors in the educational program "Mineral Processing" in the NAO "KazNITU named after K.I. Satpayev" 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 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 №. 171-VI;

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

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

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

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

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

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

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

- Industry qualifications Framework "Mining and Metallurgical Complex" from 30.07.2019, №. 1.

Currently, the list of scarce and in-demand professions of the mining and metallurgical complex of Kazakhstan, along with professions that ensure the introduction of automated systems, robotics and digital technologies, includes the profession of "enrichment".

In the world practice of ore mining and processing, there is a problem of depletion of mineral reserves or depletion of ore reserves. Therefore, in production there is a need to make technological adjustments to the methods of extraction and

enrichment of mineral raw materials. In addition, in the light of increasing environmental requirements for waste disposal, it is necessary to recycle tailings, sludge, industrial waste. Here a special role is assigned to the concentrator, who will have to own different types of technologies for processing and using man-made raw materials, determine the most effective and apply it.

The educational program "Mineral Processing" includes fundamental, natural science, general engineering and professional training of bachelors in the field of ore and man-made raw materials processing in accordance with the development of science and technology, as well as the changing needs of the mining and metallurgical industry.

Graduates of the developed educational program have knowledge of the technology of enrichment of ferrous, non-ferrous, noble, radioactive, rare and other metals, as well as processing of technogenic raw materials.

*The mission* of the educational program "Mineral Processing": preparation of bachelor-enrichers who know the mineral and raw materials base, technologies for the enrichment of ore and man-made raw materials, production technologies and areas of consumption of metals, who have fundamental training in physics, mathematics, chemistry, physico-chemical fundamentals of enrichment technologies and metallurgy. 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 processing plants, conduct experimental research using information technology and mathematical modeling.

*The field of professional activity.* Specialists who have graduated from the bachelor's degree, perform production, technological and organizational work at industrial enterprises, as well as conduct research work on the enrichment of minerals, obtaining concentrates of ores of ferrous, non-ferrous, rare and radioactive metals.

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

*The subjects of professional activity* are technological processes of mining and processing and metallurgical industry, processing of ore and man-made raw materials and obtaining concentrates of increased consumer properties, equipment of mining and metallurgical production, automatic control systems of processing production and quality control of final products.

*Types of economic activity:* screener, dispenser, crusher, concentrator, mill operator, washing machine operator, roaster, enrichment product controller, thickener apparatus, filter operator, equipment maintenance and repair mechanic, assembly repair mechanic, control panel operator, dryer, flotation, mineralogical analysis laboratory assistant.

## 2. The purpose and objectives of the educational program

*The purpose of the educational program "Mineral Processing"* is to train highly qualified, competitive and in-demand specialists in the field of mineral and man-made raw materials enrichment for the mining and metallurgical complex of the Republic of Kazakhstan, possessing professional and personal competencies that allow performing design, production and technological, research, organizational, managerial and entrepreneurial activities on the processing plants and industrial facilities.

*The objectives of the educational program "Mineral Processing":*

- study of a cycle of general education disciplines to provide social and humanitarian education based on the laws of socio-economic development of society, history, modern information technologies, the state language, foreign and Russian languages;
- study of the cycle of basic disciplines to provide knowledge of natural science, general technical and economic disciplines as the foundation of professional education;
- the cycle of profile disciplines is focused on the study of key theoretical and practical aspects of the enrichment of ore and man-made raw materials, rational use of natural resources;
- study of disciplines that form the knowledge, skills and abilities of planning and organizing research, designing works in the field of mineral processing and man-made raw materials;
- familiarization with the technologies and equipment of processing plants during the period of various types of practices.
- acquisition of skills and abilities of laboratory research, technological calculations, equipment selection and design using modern computer technologies and programs.

### **3. Requirements for the evaluation of the learning outcomes of the educational program**

#### **B – basic knowledge, skills and abilities**

B1 – to know the modern history of the Republic of Kazakhstan, stages and prospects of development of the state;

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

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

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

B5 – the ability to use knowledge and methods of general engineering disciplines (fundamentals of automation and mechanics) in practice.

B6 – awareness in the field of financial analysis and evaluation of projects, 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 of working at processing plants.

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

#### **P – professional competencies, including according to the requirements of industry professional standards**

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

P2 – proficiency in professional terminology and the ability to work with educational and scientific materials on the specialty in the original in the state, Russian and foreign languages. The ability to logically correctly, argumentatively, and clearly build oral and written speech in three languages

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

P4 – knowledge of the culture of professional safety; the ability to identify hazards and assess risks in their field; knowledge of the basic methods of protecting production personnel and the public 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 consequences in production.

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



P7 – to choose rational methods of processing ferrous and non-ferrous metal ores, man-made raw materials that meet the requirements of integrated technology, economics and ecology.

P8 – be able to realize the social significance of your future profession. Have knowledge of the formation and development of the mining and processing industry of Kazakhstan and current priority trends

P9 – to be able to combine the theory of problems and practice for solving engineering problems, to carry out balance thermal, hydraulic, aerodynamic calculations of processes and apparatuses, 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 select measuring instruments in accordance with the required accuracy and operating conditions.

P12 – be able to implement and adjust technological processes in the enrichment of mineral and man-made raw materials.

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

P14 is the ability to identify concentrating and metallurgical devices and systems for transporting melts (reagents, pulps, etc.) with low efficiency, an increased level of danger, and to 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.

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

P17 – Calculate and analyze hydrometallurgical processes and devices, choose optimal technological modes.

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

P20 – be able to execute project elements.

P21 – independently perform: calculations of equipment; drawings of parts and structural elements; calculations for strength and rigidity; calculations of machine parts and mechanisms; select electrical equipment and calculate its operating modes; propose an automation system for the main equipment.

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

P23 – to carry out a feasibility study of enrichment processes. Plan the volume of production and perform calculations of production and sales costs, determine break-even conditions. Carry out approximate calculations of harmful

emissions and assessment of the ecological state of existing and projected technological processes and units.

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

### **O – universal, social and ethical competencies**

O1 – to take a careful attitude to the environment in work and everyday life.

O2 – to 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 society's development in solving social and professional tasks, the ability to analyze socially significant problems and processes in society. Possess culture and logic of thinking, an understanding of the general laws of the development of society and the ability to analyze them.

O4 – awareness of the need and acquisition of the ability to independently study and improve their skills throughout their work.

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 (in a 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 its implementation by subordinate employees. Responsibility: for the results in the implementation of the norm; for their own safety and the safety of others; for meeting the requirements for environmental protection and fire safety. Complexity: solving various typical practical tasks that require independent analysis of work situations. Conducting the main technological process in the field of their professional activities, various levels of complexity, mentoring work in a team. Quality control of technological processes and finished products.

C3 – independence: managerial activity within the framework of the technological process section and the strategy of the enterprise. Responsibility: for

evaluating and improving one's own work, one's own training and the training of others; for one's own safety and the safety of others; for meeting the requirements for environmental protection and fire safety. Complexity: solving practical problems based on the choice of solutions in various changing working situations. Conducting work on the organization of the technological process of production, carrying out work on the development and introduction of new equipment, technologies and assortment, organizational and managerial work to improve the quality of products and production efficiency of the mining and processing industry.

C4 – independence: management activity within the framework of the company's business strategy, involving coordination of work with other sites. Responsibility: for planning and developing business processes that may lead to significant changes or development, responsibility for improving the professionalism of employees. Complexity: an activity aimed at solving problems involving a choice and a variety of solutions. Conducting research and experimental work, designing the expansion and modernization of production, expanding and updating the assortment of the mining and metallurgical industry, the introduction of new technologies.

*Special requirements for graduation in this OP:*

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

– a review meeting is held one year before the expected completion of studies in order to get acquainted with potential scientific supervisors and accelerate the students' choice of topics for a thesis (project).;

– 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 beginning of the 4th year of study;

– within 4 weeks after the start of studies, the student and the supervisor should 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, since it is impossible to further change the topic and type of work;

– the topic of the thesis (project) and the supervisor are assigned to the student or a group of students no more than six weeks after the start of the final year of study and approved by the 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 training areas	6B072 – Manufacturing and processing industries
3	Group of educational programs	B071 – Mining and mining
4	Name of the educational program	Mineral Processing
5	Brief description of the educational program	The educational program 6B07213 - "Mineral processing" (code according to the classifier of specialties of higher and postgraduate education of the Republic of Kazakhstan 2009 5B073700 – "Mineral enrichment") includes fundamental, natural science, general engineering and professional training of bachelors in the field of ore and man-made raw materials in accordance with the development of science and technology, as well as the changing needs of mining and metallurgical industries.
6	Purpose of the OP	training of highly qualified, competitive and in-demand specialists on the labor market in the field of mineral and man-made raw materials enrichment for the mining and metallurgical complex of the Republic of Kazakhstan, possessing professional and personal competencies that allow performing design, production and technological, research, organizational, managerial and entrepreneurial activities at processing plants and industrial facilities.
7	Type of OP	Новая
8	The level of the NRK	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 OP	no
11	List of competencies of the educational program:	See 4.2 Matrix of correlation of learning outcomes in the educational program as a whole with the competencies being formed
12	Learning outcomes of the educational program:	
13	Form of training	Full - time full
14	Duration of training	4 years
15	Volume of loans	240
16	Languages of instruction	Kazakh/Russian
17	Academic degree awarded	Bachelor of Engineering and Technology
18	Developer(s) and authors:	Barmenshinova M.B. Dyusenova S.B.

#### 4.2. Matrix of correlation of learning outcomes according to the educational program as a whole with the competencies being formed

Key competencies / Learning outcomes	LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8
KC1 Professional competencies			V			V	V	V
KC2 Research competencies						V	V	V
KC3 Research competencies	V	V	V					
KC4 Communication competencies				V	V			
KC5 Universal competencies				V	V			
KC6 Management competencies					V			
KC7 Cognitive competencies	V	V				V		
KC8 Creative competencies		V	V				V	V
KC9 Information and communication competencies	V	V	V				V	

### 4.3. 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	Number of credits	Generated learning outcomes (codes)							
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8
<b>Cycle of general education disciplines</b>											
<b>Required component</b>											
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. During the transition from level to level, the prerequisites and post-prerequisites of discipline 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 highlights the specifics of the scientific style in order to develop and activate professional and communicative skills and abilities of students. The course allows students to practically master the basics of scientific style and develops the ability to perform 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. Familiarization with the natural-scientific foundations of physical education, possession of modern health-improving technologies, basic methods of independent physical education and sports. And also as part of the course, the student will master the rules of judging 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, about new information technologies, local and global computer networks, methods of information protection; to acquire skills in using text editors and tabular processors; to create databases and various categories of application programs.	5				V				
5	Modern history of Kazakhstan	The course studies historical events, phenomena, facts, processes that took place on the territory of Kazakhstan from ancient times to the present day. The sections of the discipline include: introduction to the history of Kazakhstan; steppe empire of 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 the Kazakh statehood are also	5		V						

		considered: the era of the Kazakh Khanate of the XV-XVIII centuries. Kazakhstan as part of the Russian Empire; Kazakhstan during the period of civil confrontation and under the conditions of a totalitarian system; Kazakhstan during the Great Patriotic War; Kazakhstan during the period 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 existence and gives them a methodology for solving various theoretical and practical issues. Philosophy expands the horizon of vision of the modern world, forms citizenship and patriotism, promotes self-esteem, awareness of the value of human existence. It teaches how to think and act correctly, develops practical and cognitive skills, helps to search and find ways and means of living in harmony with oneself, society, and the world around us.	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 peculiarities of their functioning and development, as well as the political socialization of technical university students, ensuring the political aspect of training a highly qualified specialist on the basis of modern world and domestic political thought. The objectives of 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; the study and understanding of the laws of development of society and the ability to operate with this knowledge in professional activities; the ability to analyze social and political problems, processes, etc.	3				V				
8	Module of socio-political knowledge (cultural studies, psychology)	It is intended to familiarize students with the cultural achievements of mankind, to understand and assimilate the basic forms and universal laws of the formation and development of culture, to develop their aspirations and skills to independently comprehend the 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, the leading cultural concepts, universal patterns and mechanisms of formation and development of culture, the main historical stages of the formation and development of Kazakh culture, its most important achievements.	3				V				

		During the course, students acquire theoretical knowledge, practical skills and abilities, forming their professional orientation from the perspective of psychological aspects.										
<b>Cycle of general education disciplines</b>												
<b>Component of choice</b>												
9	Fundamentals of anti-corruption culture	Reveals the general patterns of the emergence, development and functioning of the anti-corruption culture, and organically related other social phenomena and processes.	5			V						
10	Fundamentals of Entrepreneurship and Leadership	Students will study the theory and practice of entrepreneurship as a system of economic, organizational and legal relations of business structures. The discipline is aimed at revealing the content of entrepreneurial activity, career stages, qualities, competencies and responsibilities of a modern entrepreneur, as well as theoretical and practical business planning and economic expertise of business ideas. They will develop their leadership and teamwork skills.	5			V						
11	Ecology and life safety	A brief history of ecology. Ecology of individuals (Autecology); organism and habitat. Ecology of populations (Demecology). Ecology of communities (Synecology). Ecosystems. The biosphere and its stability. Biomes. Environmental problems of our time. Sustainable development: concept, indicators, sustainable development goals. Sustainable development measures: "green economy", "green" technologies. Natural resources and rational use of natural resources. Environmental protection measures for sustainable development in the World and Kazakhstan. Environmental safety as a component of the national security of Kazakhstan. Life safety (BZHD) in the technosphere. Natural and man-made emergencies. Organizational bases for the protection of the population from emergencies. Sustainability of production in emergency conditions. Basic safety requirements for industrial equipment. Occupational injuries and its main causes. Investigation, accounting and methods of analysis of the causes of occupational injuries in mining and oil production. Working conditions and basic requirements for ensuring safe working conditions. The impact on the body of chemically hazardous substances Microclimate and comfortable living conditions. Systems for providing microclimate parameters. Industrial lighting. Protection against vibration, noise, ultra- and infrasound. Protection against electromagnetic fields and laser radiation. Protection against ionizing radiation. Lightning protection, static electricity, electrical safety. Safety of equipment	5			V						



		operation under pressure. Safety of operation of lifting cranes. Fire and explosion safety. Fire safety systems and means.										
<b>Cycle of basic disciplines</b>												
<b>University component</b>												
12	Mathematics I	The course is based on the study of mathematical analysis in a volume that allows you to explore elementary functions and solve the simplest geometric, physical and other applied problems. The main focus is on differential and integral calculus. The sections of the course include differential calculus of functions of one variable, derivative and differentials, the study of the behavior of functions, complex numbers, polynomials. Indefinite integrals, their properties and methods of calculation. Definite integrals and their applications. Improper integrals.	5	V								
13	Mathematics II	The discipline is a continuation of Mathematics 1. The sections of the course include: elements of linear algebra and analytical geometry. Differential calculus of a function of several variables and its applications. Multiple integrals. The objectives of the course are to instill in students solid skills in solving mathematical problems with bringing the solution to a practically acceptable result. To develop primary skills of mathematical research of applied issues and the ability to independently understand the mathematical apparatus contained in the literature related to the student's specialty.	5		V							
14	Physics I	The course studies the basic physical phenomena and laws of classical and modern physics; methods of physical research; the influence of physics as a science on the development of technology; the relationship of physics with other sciences and its role in solving scientific and technical problems of the specialty. The course covers the following sections: mechanics, dynamics of rotational motion of a solid, mechanical harmonic waves, fundamentals of molecular kinetic theory and thermodynamics, transport phenomena, continuum mechanics, electrostatics, direct current, magnetic field, Maxwell equations.	5	V								
15	Engineering and computer graphics	The course develops the following skills among students: to depict all possible combinations of geometric shapes on a plane, to carry out research and their measurements, allowing for image transformations; to create technical drawings, which are the main and reliable means of information that provides communication between the designer and the designer, technologist, builder. Introduces students to the basics of automated preparation of the graphic part of design documents in the AutoCAD environment.	5	V								

16	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 for the production of metals have been studied. Concepts of minerals and deposits. Mineral deposits of the Republic of Kazakhstan.	4	V								
17	General chemistry	Basic concepts and laws of chemistry; fundamental laws of chemical thermodynamics and kinetics; quantum mechanical theory of atomic structure and chemical bonding. Solutions and their types, redox processes, coordination compounds: formation, stability and properties. The structure of matter and the chemistry of elements.	5		V							
18	Fundamentals of Mineral Processing (in English)	The course covers the fundamental sections: the processes of preparation of mineral raw materials for enrichment, the basic laws 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 solid minerals, the design of devices used in various stages of mineral processing technologies, wastewater treatment technologies and waste storage of processing plants, quality control, manufactured products, research on enrichment.	6			V						
19	Ore preparation processes and equipment	Ore preparation is widely used in the processes of processing ores of ferrous and non-ferrous metals, rare metal and gold-containing raw materials, as well as non-metallic raw materials, construction materials and other areas of the national economy of the Republic of Kazakhstan. In this course, the technological processes of ore preparation and enrichment, the design of the equipment used, methods of calculation and selection of main and auxiliary equipment, operation of crushing and grinding equipment are studied in detail.	5				V					
20	Physical chemistry	Physical chemistry is an important part of chemistry that studies the relationship between chemical and physical processes. The main questions of physical chemistry are: why does the physico-chemical process occur; in this case, it is necessary to change the reaction state for the desired direction; the process can move to the relationship between primary reagents and products; What is the structure and properties of the substance in the physico-chemical process. Determining the behavior of a chemical reaction allows you to control the chemical process, which means that it ensures that the most important reactions for technology are quickly and completely	5			V						

		obtained in the right direction and the most profitable for industry										
21	Fundamentals of mining technology	Features of extraction of solid minerals by open and underground methods. Preparation of rocks for excavation (drilling and blasting), excavation and loading operations, transportation of ore and waste rocks, dumping and warehousing. Averaging and loading complexes. Methods of intra-quarry averaging of ore.	5					V				
22	Metrology and standardization in the processing industry	The discipline "Metrology and standardization in enrichment production" occupies a leading place in the technological training of students, is the basis for studying the disciplines of the profile disciplines of the specialty. The course "Metrology and standardization in enrichment production" includes the study of the main provisions, concepts and definitions in the field of metrology and standardization; the state system of metrology and standardization and their role in accelerating scientific and technological progress; acquisition of knowledge in the field of metrology and standardization in processing production, measurement methods and quality assessment of technical measurements; tolerance field systems in the design of components and parts of machines, equipment of processing production, methods of ensuring the accuracy of production products.	5					V				
23	Gravitational enrichment methods	In this course, the following are studied in detail: Theoretical foundations of gravity enrichment; Hydraulic and pneumatic classification processes and apparatuses; Enrichment in heavy media; Enrichment by jigging; Enrichment in a stream of water flowing along an inclined surface; Pneumatic enrichment; Ore washing.	5					V				
24	General Metallurgy (in English)	This course is an introductory part of metallurgy and helps the student to master the basic terms and definitions in metallurgy, the general principles of the development of technological processes, as well as the structures and principles of the main metallurgical units	5					V				
25	Basics of automation	The content of the discipline includes questions of classification of control systems, mathematical description of linear systems with transfer functions, construction of schemes of automatic control systems. Study of the structure, principles of operation and application of various elements, devices used in the automation of various processes.	5					V				
26	Chemistry of flotation reagents (in English)	The discipline studies the theoretical foundations of changes in the surface properties of minerals, the role of crystal structure features and types of interatomic bonds in this, the effect of isomorphic impurities on the flotation properties of minerals, the appearance of anode and cathode sites on the surface, the role of crystal energy in	4					V				

		adsorption processes, semiconductor properties of minerals, mineral solubility, chemisorption and molecular adsorption, the bond strength of adsorbed ions with the elements of the crystal lattice, the change in surface energy at the solid-liquid boundary, hydrophobization and hydrophilization of the surface.										
27	Power supply and electrical equipment of processing plants	In this course, the issues of power supply and electrical equipment of processing plants and the features of power sources are studied. Modern schemes of external and internal power supply are highlighted. The schemes of power supply and distribution of electricity at processing plants are given. Transformer substations of processing plants. Electrical equipment of substation switchgears. Constructive execution of lines and networks. Calculation of electrical networks. Low voltage power distribution schemes. Classification of electric motors and selection of electric motors by type of current, voltage and power. Protection and control equipment. Devices and schemes of automatic accounting. Electric lighting of the processing plant. The choice of the power of light sources and the choice of lighting system. The choice of lighting system and methods of laying lighting networks. Energy indicators. Determination of the power of the compensating device to increase the power factor. Electrical safety, protective earthing and zeroing	5						V			
<b>Cycle of basic disciplines</b>												
<b>Elective component</b>												
28	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 mineral processing processes (a combination of enrichment processes and metallurgical operations). Fine-tuning of substandard concentrates.	5					V				
29	Enrichment of gold-bearing ores and technogenic raw materials	Characteristics of gold-bearing ores and technogenic raw materials. General characteristics of technological processes. Gravity-flotation technologies. Hydrochemical processes of ore and concentrate processing. Pyrometallurgical processes of processing concentrates. Refining processing of gold-containing materials. Neutralization of enrichment wastewater and gold leaching solutions.	5					V				
30	Hydroaeromechanics of enrichment processes	The discipline studies the physical properties of liquids and gases, the basics of hydrostatics and hydrodynamics, the laws of motion of	5					V				

		bodies in the medium, free and constrained motion, the equation of motion of bodies, fluid motion through granular and porous layers, fluid dynamics of fluidized layers, filtration through porous partitions, two and three-phase systems, suspensions, hydroaeromechanical processes occurring during the enrichment of minerals fossils, aeration and mixing of suspensions									
31	Coal enrichment	Technological characteristics of coals and evaluation of the results of their enrichment. Methods and processes of coal enrichment. Enrichment of coking coals. Enrichment of energy coals. Enrichment of brown coal and oil shale. Complex use of mineral and organic components of coals. Coal-processing plants. Environmental protection.	5				V				
32	Processes and devices of enrichment production	The course examines the theoretical foundations of processes, describes the designs of standard devices and methods of their calculation, highlights the issues of maintenance of devices.	5				V				
33	Auxiliary facilities in the OPI	The discipline studies the devices and operation of water supply devices, air supply, transportation of products at processing plants, the theoretical foundations of dewatering and dust collection processes, the design and principle of operation of devices used for drainage, centrifugation, thickening, filtration, drying and dust collection. Methods for the selection and calculation of the main auxiliary equipment and dehydration schemes are considered. The relationship of the auxiliary economy with the technological processes of enrichment. Methods of calculations and selection of auxiliary equipment, as well as the structure of the auxiliary economy.	5				V				
34	Automation of production processes at processing plants	The course provides for the study of the following main topics for mastering the discipline automation of enrichment: concepts of control objects, control systems; methods for measuring the main technological variables of enrichment processes (temperature, flow, level, pressure, concentration of substances, PH measurement of solutions, conductometry, etc.); creation of automated process control systems (automated process control systems), purpose and the composition of the automated control system, varieties of automated control systems; mathematical models of objects, mathematical models of typical flows and kinetics of homogeneous and heterogeneous chemical reactions; experimental determination of properties of objects, acceleration curve, transients.	5					V			
35	Flotation reagents in OPI	Basic theories of flotation in its current state. The research methods of the action of flotation reagents and the mechanism of the flotation	5					V			

		process are described in detail, as well as the processing of the results obtained. The fundamentals of the theory and practice of the use of flotation reagents in the flotation of ores of non-ferrous and related rare metals are described. The structure and composition, physical and chemical properties of the reagents are described.										
36	Theory and practice of hydrometallurgical processes	Fuel combustion. Physico-chemical laws of reactions of gorenje gases and gasification of carbon. Carbonates and oxides formation and thermal dissociation. Regularities of formation and thermal dissociation of oxides and carbonates. Reduction of metal oxides. Theory of reduction of oxides by gaseous reducing agents and solid carbon. Thermodynamics and kinetics of metallurgical melts. Thermodynamics and kinetics of the behavior of harmful impurities. Theoretical foundations of processes occurring during oxidative refining, desulfurization, deoxidation and degassing of iron melts.	5						V			
37	Development of innovative equipment in enrichment	New designs of crushers for the modernization of the crushing process. Prospects for technical re-equipment of screening units of processing plants. Modernization of technological processes of ore preparation. A new generation of highly efficient screens for bulk materials and pulps. Knelson gravity technologies. Intensification of the deposition process. Modern equipment for magnetic enrichment methods. New generation flotation machines. Intensification of the dewatering process by upgrading disk vacuum filters.	5						V			
38	Technologies for the enrichment of non-ferrous metal ores	Raw material base of non-ferrous metallurgy. Technology of preparation of non-ferrous metal ores. The importance of ore quality management during enrichment. Comparative characteristics of pre-concentration methods in the enrichment of non-ferrous metal ores. Schemes of enrichment of ores of non-ferrous metals. Technological schemes and modes of enrichment of copper ores. Polymetallic ore enrichment schemes. Polymetallic ore enrichment modes	6							V		
39	Reagent economy of processing plants	Reagent economy of processing plants. Warehouses of dry and liquid reagents and oils. Reagent department. Dosing platforms. Equipment for preparation and dosage of reagents.	6							V		
<b>Cycle of profile disciplines</b>												
<b>University component</b>												
40	Tailings and wastewater treatment	Classification of waste. Methods and places of waste storage. Chemical and mineralogical composition of waste. Current and stale tailings of processing plants. Methods of processing stale tailings 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	5							V		

		technologies for the processing of solid household waste.										
41	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. The list of controlled parameters. The minimum mass of the sample for analysis: chemical, granulometric, fractional. Sample preparation. Control of enrichment processes. Technological and commodity balance. Organization of testing and control.	5								V	
42	Operation and repair of processing equipment	The discipline studies the devices and operation of water supply, air supply, transportation of products at processing plants, bunkering, storage of raw materials and enrichment products. The interrelation of auxiliary economy with technological processes of enrichment is considered. The methods of calculations and selection of auxiliary equipment, as well as the structure of the auxiliary economy are studied	6								V	
43	Flotation methods of enrichment	The physicochemical foundations of the flotation process are considered. The reasons for the appearance of free energy at the interphase boundaries. The use of flotation reagents to regulate energy changes at phase boundaries. Adsorption processes on the phase sections. Classification of flotation reagents and their role in flotation. The mechanism of action of reagents. Flotation machines, features of their designs and applications. Flotation schemes of enrichment. Brief information about the use of reagents in flotation enrichment of various types of ores.	4							V		
<b>Cycle of profile disciplines</b>												
<b>Component of choice</b>												
44	Enrichment of polymetallic ores	Non-ferrous metal ores 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, feldspar and other elements, and minerals that are extremely necessary for various sectors of the national economy of the Republic of Kazakhstan. The course is devoted to the study of a variety of technological schemes, reagent modes and methods of enrichment of polymetallic ores.	5								V	
45	Technologies for processing uranium-containing ores and concentrates	Mechanical processing of uranium ores. Acid and carbonate leaching of uranium ores. Underground leaching of uranium. The phenomenon of colmatation of wells. Thickening. Sorption method of uranium concentration. Classification of ion-exchange materials and basic requirements for ionites. Regeneration of a sorbent saturated with uranium. Fundamentals of the process of extraction purification of uranium compounds. Precipitation methods for obtaining chemical concentrate of natural uranium. Filtering. Drying	5								V	





		about mining and chemical raw materials and raw materials base is given. Consumer requirements for enrichment products. The current state in the field of enrichment and processing, prospects for further development of this branch of production.										
52	Underground ore leaching technology	Physico-chemical bases of the processes of dissolution of metals during leaching. Natural properties of raw materials used in leaching. Preparation of raw materials for the leaching process. Heap and underground leaching of metals. Processing of productive solutions, bacterial-chemical underground and heap leaching. Prospects for the development and use of leaching processes. Environmental aspects of heap and underground leaching technology. Underground leaching is used to process the mined areas of copper deposits by special pouring of acid solutions. Leaching solutions are directed to the extraction of copper by cementation.	5								V	
53	Magnetic and electric enrichment methods	Magnetic and special methods of enrichment, ore-picking 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 of its processing using combined processes (enrichment and metallurgy). Finishing of concentrates conditioned by the base metal, but defective by impurities. Processing of collective concentrates obtained by enrichment methods using pyro- and hydrometallurgical operations.	5									V
54	Enrichment of ferrous metal ores	The material composition of ore raw materials. Theoretical foundations and features of the enrichment of various ferrous metal ores. Principles and conditions of separation of ore minerals from aggregates with non-metallic minerals, ore enrichment and its definition. Classification of methods and processes of ore enrichment based on separating forces. Schemes and devices for the enrichment of magnetite, titanomagnetite and other ores of complex composition, oxidized iron ores and quartzites, brown iron ore, manganese and chromium ores, carbonate iron and manganese ores. Work experience of factories for the enrichment of ferrous ores. Ways of complex use of mineral raw materials of ferrous metals.	5									V
55	Special and combined enrichment methods	Специальные методы обогащения, рудоразборка минерального 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 of its processing using combined processes (enrichment and metallurgy). Finishing of concentrates conditioned by the base metal, but defective by impurities. Processing of collective concentrates obtained by enrichment	5									V



#### 4.4. Information about modules/disciplines

№	Name of the discipline	Brief description of the discipline (30-50 words)	Number of credits	Formed competencies (codes)
<b>Cycle of general education disciplines University component</b>				
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. During the transition from level to level, the prerequisites and post-prerequisites of discipline are observed.	10	KC3, KC7, KC9
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 highlights the specifics of the scientific style in order to develop and activate professional and communicative skills and abilities of students. The course allows students to practically master the basics of scientific style and develops the ability to perform structural and semantic analysis of the text.	10	KC3, KC7, KC9
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. Familiarization with the natural-scientific foundations of physical education, possession of modern health-improving technologies, basic methods of independent physical education and sports. And also as part of the course, the student will master the rules of judging in all sports.	8	KC3, KC7, KC9
4	Information and communication technologies (in English)	The task of studying the discipline is to acquire theoretical knowledge about information processes, about new information technologies, local and global computer networks, methods of information protection; to acquire skills in using text editors and tabular processors; to create databases and various categories of application programs.	5	KC4, KC5
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.	5	KC3, KC7, KC8, KC9
6	Philosophy	Philosophy forms and develops critical and creative thinking, worldview and culture, provides knowledge about the most general and fundamental problems of existence and gives them a methodology for solving various theoretical and practical issues.	5	KC4, KC5
7	Module of socio-political	Formation of theoretical knowledge about	3	KC4, KC5

	knowledge (sociology, political science)	society as an integral system, its structural elements, connections and relations between them, the peculiarities of their functioning and development, as well as the political socialization of technical university students, ensuring the political aspect of training a highly qualified specialist on the basis of modern world and domestic political thought.		
8	Module of socio-political knowledge (cultural studies, psychology)	It is intended to familiarize students with the cultural achievements of mankind, to understand and assimilate the basic forms and universal laws of the formation and development of culture, to develop their aspirations and skills to independently comprehend the wealth of values of world culture for self-improvement and professional growth.	3	KC1, KC3, KC8, KC9
<b>Cycle of general education disciplines</b>				
<b>Component of choice</b>				
9	Fundamentals of anti-corruption culture	Reveals the general patterns of the emergence, development and functioning of the anti-corruption culture, and organically related other social phenomena and processes.	5	KC1, KC3, KC8, KC9
10	Fundamentals of Entrepreneurship and Leadership	The discipline is aimed at revealing the content of entrepreneurial activity, career stages, qualities, competencies and responsibilities of a modern entrepreneur, as well as theoretical and practical business planning and economic expertise of business ideas. They will develop their leadership and teamwork skills.	5	KC1, KC3, KC8, KC9
11	Ecology and life safety	A brief history of ecology. Ecology of individuals (Autecology); organism and habitat. Ecology of populations (Demecology). Ecology of communities (Synecology). Ecosystems. The biosphere and its stability. Biomes. Environmental problems of our time. Life safety (BZHD) in the technosphere. Natural and man-made emergencies. Organizational bases for the protection of the population from emergencies. Basic safety requirements for industrial equipment.	5	KC1, KC3, KC8, KC9
<b>Cycle of basic disciplines</b>				
<b>University component</b>				
12	Mathematics I	The course is based on the study of mathematical analysis in a volume that allows you to explore elementary functions and solve the simplest geometric, physical and other applied problems. The main focus is on differential and integral calculus. The sections of the course include differential calculus of functions of one variable, derivative and differentials, the study of the behavior of functions, complex numbers, polynomials.	5	KC3, KC7, KC9
13	Mathematics II	The discipline is a continuation of Mathematics 1. The sections of the course include: elements of linear algebra and	5	KC3, KC7, KC8, KC9

		analytical geometry. Differential calculus of a function of several variables and its applications. Multiple integrals.		
14	Physics I	The course studies the basic physical phenomena and laws of classical and modern physics; methods of physical research; the influence of physics as a science on the development of technology; the relationship of physics with other sciences and its role in solving scientific and technical problems of the specialty.	5	KC3, KC7, KC9
15	Engineering and computer graphics	The course develops students' skills: to depict all possible combinations of geometric shapes on a plane, to carry out research and their measurements, allowing for image transformations; to create technical drawings, which are the main and reliable means of information that provides communication between the designer and the designer, technologist, builder. Introduces students to the basics of automated preparation of the graphic part of design documents in the AutoCAD environment.	5	KC3, KC7, KC9
16	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 for the production of metals have been studied. Concepts of minerals and deposits. Mineral deposits of the Republic of Kazakhstan.	4	KC3, KC7, KC9
17	General chemistry	Basic concepts and laws of chemistry; fundamental laws of chemical thermodynamics and kinetics; quantum mechanical theory of atomic structure and chemical bonding. Solutions and their types, redox processes, coordination compounds: formation, stability and properties. The structure of matter and the chemistry of elements.	5	KC3, KC7, KC8, KC9
18	Fundamentals of Mineral Processing (in English)	The course covers the fundamental sections: the processes of preparation of mineral raw materials for enrichment, the basic laws 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 solid minerals, the design of devices used in various stages of mineral processing technologies, wastewater treatment technologies and waste storage of processing plants, quality control, manufactured products, research on enrichment.	6	KC1, KC3, KC8, KC9
19	Ore preparation processes	Ore preparation is widely used in the	5	KC4, KC5

	and equipment	processes of processing ores of ferrous and non-ferrous metals, rare metal and gold-containing raw materials, as well as non-metallic raw materials, construction materials and other areas of the national economy of the Republic of Kazakhstan. In this course, the technological processes of ore preparation and enrichment, the design of the equipment used, methods of calculation and selection of main and auxiliary equipment, operation of crushing and grinding equipment are studied in detail.		
20	Physical chemistry	Physical chemistry is an important part of chemistry that studies the relationship between chemical and physical processes. The main questions of physical chemistry are: why does the physico-chemical process occur; in this case, it is necessary to change the reaction state for the desired direction; the process can move to the relationship between primary reagents and products; What is the structure and properties of the substance in the physico-chemical process. Determining the behavior of a chemical reaction allows you to control the chemical process, which means that it ensures that the most important reactions for technology are quickly and completely obtained in the right direction and the most profitable for industry	5	KC1, KC3, KC8, KC9
21	Fundamentals of mining technology	Features of extraction of solid minerals by open and underground methods. Preparation of rocks for excavation (drilling and blasting), excavation and loading operations, transportation of ore and waste rocks, dumping and warehousing. Averaging and loading complexes. Methods of intra-quarry averaging of ore.	5	KC4, KC5
22	Metrology and standardization in the processing industry	The discipline "Metrology and standardization in enrichment production" occupies a leading place in the technological training of students, is the basis for studying the disciplines of the profile disciplines of the specialty. The course "Metrology and standardization in enrichment production" includes the study of the main provisions, concepts and definitions in the field of metrology and standardization; the state system of metrology and standardization and their role in accelerating scientific and technological progress; acquisition of knowledge in the field of metrology and standardization in processing production, measurement methods and quality assessment of technical measurements; tolerance field systems in the design of	5	KC4, KC5, KC6

		components and parts of machines, equipment of processing production, methods of ensuring the accuracy of production products.		
23	Gravitational enrichment methods	In this course, the following are studied in detail: Theoretical foundations of gravity enrichment; Hydraulic and pneumatic classification processes and apparatuses; Enrichment in heavy media; Enrichment by jigging; Enrichment in a stream of water flowing along an inclined surface; Pneumatic enrichment; Ore washing.	5	KC4, KC5, KC6
24	General Metallurgy (in English)	This course is an introductory part of metallurgy and helps the student to master the basic terms and definitions in metallurgy, the general principles of the development of technological processes, as well as the structures and principles of the main metallurgical units	5	KC4, KC5, KC6
25	Basics of automation	The content of the discipline includes questions of classification of control systems, mathematical description of linear systems with transfer functions, construction of schemes of automatic control systems. Study of the structure, principles of operation and application of various elements, devices used in the automation of various processes	5	KC4, KC5, KC6
26	Chemistry of flotation reagents (in English)	The discipline studies the theoretical foundations of changes in the surface properties of minerals, the role of crystal structure features and types of interatomic bonds in this, the effect of isomorphic impurities on the flotation properties of minerals, the appearance of anode and cathode sites on the surface, the role of crystal energy in adsorption processes, semiconductor properties of minerals, mineral solubility, chemisorption and molecular adsorption, the bond strength of adsorbed ions with the elements of the crystal lattice, the change in surface energy at the solid-liquid boundary, hydrophobization and hydrophilization of the surface.	4	KC4, KC5, KC6
27	Power supply and electrical equipment of processing plants	In this course, the issues of power supply and electrical equipment of processing plants and the features of power sources are studied. Modern schemes of external and internal power supply are highlighted. The schemes of power supply and distribution of electricity at processing plants are given. Transformer substations of processing plants. Electrical equipment of substation switchgears. Constructive execution of lines and networks. Calculation of electrical networks. Low voltage power distribution schemes. Classification of electric motors and selection of electric motors by type of current, voltage and power. Protection and control equipment. Devices and schemes	5	KC1, KC2, KC7

		of automatic accounting. Electric lighting of the processing plant. The choice of the power of light sources and the choice of lighting system. The choice of lighting system and methods of laying lighting networks. Energy indicators. Determination of the power of the compensating device to increase the power factor. Electrical safety, protective earthing and zeroing		
<b>Basic disciplines</b> <b>Component of choice</b>				
28	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 mineral processing processes (a combination of enrichment processes and metallurgical operations). Fine-tuning of substandard concentrates.	5	KC1, KC3, KC8, KC9
29	Enrichment of gold-bearing ores and technogenic raw materials	Characteristics of gold-bearing ores and technogenic raw materials. General characteristics of technological processes. Gravity-flotation technologies. Hydrochemical processes of ore and concentrate processing. Pyrometallurgical processes of processing concentrates. Refining processing of gold-containing materials. Neutralization of enrichment wastewater and gold leaching solutions.	5	KC1, KC3, KC8, KC9
30	Hydroaeromechanics of enrichment processes	The discipline studies the physical properties of liquids and gases, the basics of hydrostatics and hydrodynamics, the laws of motion of bodies in the medium, free and constrained motion, the equation of motion of bodies, fluid motion through granular and porous layers, fluid dynamics of fluidized layers, filtration through porous partitions, two and three-phase systems, suspensions, hydroaeromechanical processes occurring during the enrichment of minerals fossils, aeration and mixing of suspensions	5	KC4, KC5
31	Coal enrichment	Technological characteristics of coals and evaluation of the results of their enrichment. Methods and processes of coal enrichment. Enrichment of coking coals. Enrichment of energy coals. Enrichment of brown coal and oil shale. Complex use of mineral and organic components of coals. Coal-processing plants. Environmental protection.	5	KC4, KC5
32	Processes and devices of enrichment production	The course examines the theoretical foundations of processes, describes the designs of standard devices and methods of their calculation, highlights the issues of maintenance of devices.	5	KC4, KC5, KC6
33	Auxiliary facilities in the	The discipline studies the devices and	5	KC4, KC5, KC6



	OPI	operation of water supply devices, air supply, transportation of products at processing plants, the theoretical foundations of dewatering and dust collection processes, the design and principle of operation of devices used for drainage, centrifugation, thickening, filtration, drying and dust collection. Methods for the selection and calculation of the main auxiliary equipment and dehydration schemes are considered. The relationship of the auxiliary economy with the technological processes of enrichment. Methods of calculations and selection of auxiliary equipment, as well as the structure of the auxiliary economy.		
34	Automation of production processes at processing plants	The course provides for the study of the following main topics for mastering the discipline automation of enrichment: concepts of control objects, control systems; methods for measuring the main technological variables of enrichment processes (temperature, flow, level, pressure, concentration of substances, PH measurement of solutions, conductometry, etc.); creation of automated process control systems (automated process control systems), purpose and the composition of the automated control system, varieties of automated control systems; mathematical models of objects, mathematical models of typical flows and kinetics of homogeneous and heterogeneous chemical reactions; experimental determination of properties of objects, acceleration curve, transients.	5	KC1, KC2, KC7
35	Flotation reagents in OPI	Basic theories of flotation in its current state. The research methods of 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 the use of flotation reagents in the flotation of ores of non-ferrous and related rare metals are described. The structure and composition, physical and chemical properties of the reagents are described.	5	KC1, KC2, KC7
36	Theory and practice of hydrometallurgical processes	Fuel combustion. Physico-chemical laws of reactions of gaseous gases and gasification of carbon. Carbonates and oxides formation and thermal dissociation. Regularities of formation and thermal dissociation of oxides and carbonates. Reduction of metal oxides. Theory of reduction of oxides by gaseous reducing agents and solid carbon. Thermodynamics and kinetics of metallurgical melts. Thermodynamics and kinetics of the behavior of harmful impurities. Theoretical foundations of processes occurring during oxidative refining,	5	KC1, KC2, KC7

		desulfurization, deoxidation and degassing of iron melts.		
37	Development of innovative equipment in enrichment	New designs of crushers for the modernization of the crushing process. Prospects for technical re-equipment of screening units of processing plants. Modernization of technological processes of ore preparation. A new generation of highly efficient screens for bulk materials and pulps. Knelson gravity technologies. Intensification of the deposition process. Modern equipment for magnetic enrichment methods. New generation flotation machines. Intensification of the dewatering process by upgrading disk vacuum filters.	5	KC1, KC2, KC7
38	Technologies for the enrichment of non-ferrous metal ores	Raw material base of non-ferrous metallurgy. Technology of preparation of non-ferrous metal ores. The importance of ore quality management during enrichment. Comparative characteristics of pre-concentration methods in the enrichment of non-ferrous metal ores. Schemes of enrichment of ores of non-ferrous metals. Technological schemes and modes of enrichment of copper ores. Polymetallic ore enrichment schemes. Polymetallic ore enrichment modes.	6	KC1, KC2, KC8, KC9
39	Reagent economy of processing plants	Reagent economy of processing plants. Warehouses of dry and liquid reagents and oils. Reagent department. Dosing platforms. Equipment for preparation and dosage of reagents.	6	KC1, KC2, KC8, KC9
<b>Cycle of profile disciplines</b>				
<b>University component</b>				
40	Хвостовое хозяйство и очистка сточных вод	Classification of waste. Methods and places of waste storage. Chemical and mineralogical composition of waste. Current and stale tailings of processing plants. Methods of processing stale tailings 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.	5	KC1, KC2, KC8, KC9
41	Опробование и контроль обогатительных процессов	Basic concepts about the process of testing minerals, products of their enrichment, control of technological processes at processing plants. The list of controlled parameters. The minimum mass of the sample for analysis: chemical, granulometric, fractional. Sample preparation. Control of enrichment processes. Technological and commodity balance. Organization of testing and control.	5	KC1, KC2, KC8, KC9
42	Эксплуатация и ремонт обогатительного оборудования	The discipline studies the devices and operation of water supply, air supply, transportation of products at processing plants, bunkering, storage of raw materials	6	KC1, KC2, KC8, KC9

		and enrichment products. The interrelation of auxiliary economy with technological processes of enrichment is considered. The methods of calculations and selection of auxiliary equipment, as well as the structure of the auxiliary economy are studied.		
43	Флотационные методы обогащения	The physicochemical foundations of the flotation process are considered. The reasons for the appearance of free energy at the interphase boundaries. The use of flotation reagents to regulate energy changes at phase boundaries. Adsorption processes on the phase sections. Classification of flotation reagents and their role in flotation. The mechanism of action of reagents. Flotation machines, features of their designs and applications. Flotation schemes of enrichment. Brief information about the use of reagents in flotation enrichment of various types of ores.	4	KC1, KC2, KC7
<b>Cycle of profile disciplines Component of choice</b>				
44	Enrichment of polymetallic ores	Non-ferrous metal ores 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, feldspar and other elements, and minerals that are extremely necessary for various sectors of the national economy of the Republic of Kazakhstan. The course is devoted to the study of a variety of technological schemes, reagent modes and methods of enrichment of polymetallic ores.	5	KC1, KC2, KC7
45	Technologies for processing uranium-containing ores and concentrates	Mechanical processing of uranium ores. Acid and carbonate leaching of uranium ores. Underground leaching of uranium. The phenomenon of colmatation of wells. Thickening. Sorption method of uranium concentration. Classification of ion-exchange materials and basic requirements for ionites. Regeneration of a sorbent saturated with uranium. Fundamentals of the process of extraction purification of uranium compounds. Precipitation methods for obtaining chemical concentrate of natural uranium. Filtering. Drying and calcining.	5	KC1, KC2, KC7
46	Enrichment of rare metal ores	T types and deposits of rare ores. Preliminary enrichment of ores and placers of rare metals. Ore preparation operations in the processing of ores and placers of rare metals. Technology of enrichment and integrated use of the main types of ores and placers (tungsten and tungsten-molybdenum, tin and tin-polymetallic ores, titanium-zirconium ores and placers, tantalum-niobium ores and placers, etc.).	4	KC1, KC2, KC7
47	Ore processing research	The discipline studies methods of	4	KC1, KC2, KC7

		sampling technological samples, preparing them for research on 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.		
48	Dewatering and dust collection	The discipline studies the theoretical foundations of dewatering and dust collection processes, the design and principle of operation of devices used for drainage, centrifugation, thickening, filtration, drying and dust collection. Methods for the selection and calculation of the main auxiliary equipment and dehydration schemes are considered.	4	KC1, KC2, KC7
49	Modeling of enrichment processes	Methods of making models of enrichment processes. Obtaining high technological indicators by performing experiments using mathematical planning methods. Preparation of planning matrices, estimation of experimental variance, determination of the adequacy of the obtained model and its application. General issues of modeling production systems. Application of theoretical relations and statistical methods for mathematical description of enrichment processes.	6	KC1, KC2, KC8, KC9
50	Geotechnological methods of enrichment	The discipline studies 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.	6	KC1, KC2, KC8, KC9
51	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 of choosing processing schemes and evaluating technical and economic indicators, analyzing the material and mineralogical composition of ore to choose the most effective technological scheme of enrichment. General information about mining and chemical raw materials and raw materials base is given. Consumer requirements for enrichment products. The current state in the field of enrichment and processing, prospects for further development of this branch of production.	5	KC1, KC2, KC8, KC9
52	Underground ore leaching	Physico-chemical bases of the processes	5	KC1, KC2, KC8,

	technology	of dissolution of metals during leaching. Natural properties of raw materials used in leaching. Preparation of raw materials for the leaching process. Heap and underground leaching of metals. Processing of productive solutions, bacterial-chemical underground and heap leaching. Prospects for the development and use of leaching processes. Environmental aspects of heap and underground leaching technology. Underground leaching is used to process the mined areas of copper deposits by special pouring of acid solutions. Leaching solutions are directed to the extraction of copper by cementation.		KC9
53	Magnetic and electric enrichment methods	Magnetic and special methods of enrichment, ore-picking 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 of its processing using combined processes (enrichment and metallurgy). Finishing of concentrates conditioned by the base metal, but defective by impurities. Processing of collective concentrates obtained by enrichment methods using pyro- and hydrometallurgical operations.	5	KC1, KC2, KC8
54	Enrichment of ferrous metal ores	The material composition of ore raw materials. Theoretical foundations and features of the enrichment of various ferrous metal ores. Principles and conditions of separation of ore minerals from aggregates with non-metallic minerals, ore enrichment and its definition. Classification of methods and processes of ore enrichment based on separating forces. Schemes and devices for the enrichment of magnetite, titanomagnetite and other ores of complex composition, oxidized iron ores and quartzites, brown iron ore, manganese and chromium ores, carbonate iron and manganese ores. Work experience of factories for the enrichment of ferrous ores. Ways of complex use of mineral raw materials of ferrous metals.	5	KC1, KC2, KC8
55	Special and combined enrichment methods	Special methods of enrichment, ore-picking 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 of its processing using combined processes (enrichment and metallurgy). Finishing of concentrates conditioned by the base metal, but defective by impurities. Processing of collective concentrates obtained by enrichment methods using pyro- and hydrometallurgical operations.	5	KC1, KC2, KC8

56	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 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.	5	KC1, KC2, KC8
57	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	KC1, KC2, KC8
58	Digitalization of mining and processing plants	The role of digital technologies in improving the economic management mechanism in the mining and processing industry. Complex tasks related to the processing of ore and man-made raw materials can be controlled 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.	5	KC1, KC2, KC8

## 5. Curriculum of the educational program

MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN  
KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K.I.SATPAEV



### CURRICULUM

of Educational Program on enrollment for 2022-2023 academic year

Educational program 6B07213 - "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																		
Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	classroom volume of lsk/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									
<b>CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)</b>																								
<b>M-1. Module of language training</b>																								
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															
<b>M-2. Module of physical training</b>																								
KFK101-104	Physical Culture	GED, RC	8	240	0/0/8	120	Difcredit	2	2	2	2													
<b>M-3. Module of information technology</b>																								
CSE677	Information and communication technologies (in English)	GED, RC	5	150	2/1/0	105	E					5												
<b>M-4. Module of socio-cultural development</b>																								
HUM100	Modern 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, politicalogy)	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													
<b>M-5. Module of anti-corruption culture, ecology and life safety base</b>																								
HUM133	Fundamentals of anti-corruption culture	GED, CCH																						
MNG488	Fundamentals of Entrepreneurship and Leadership		5	150	2/0/1	105	E				5													
CHE656	Ecology and life safety																							
<b>CYCLE OF BASIC DISCIPLINES (BD)</b>																								
<b>M-6. Module of physical and mathematical training</b>																								
MAT101	Mathematics I	BD, UC	5	150	1/0/2	105	E	5																
PHY111	Physics I	BD, UC	5	150	1/1/1	105	E	5																
MAT102	Mathematics II	BD, UC	5	150	1/0/2	105	E		5															
<b>M-7. Module of basic training</b>																								
GEN429	Engineering and computer graphics	BD, UC	5	150	1/0/2	105	E	5																
CHE495	Chemistry	BD, UC	5	150	1/1/1	105	E		5															
CHE127	Physical chemistry	BD, UC	5	150	1/1/1	105	E			5														
2201	Elective	BD, CCH	5	150	2/1/0*	105	E			5														
2202	Elective	BD, CCH	5	150	2/1/0*	105	E				5													
AUT424	Basics of automation	BD, UC	5	150	2/1/0	105	E					5												
3203	Elective	BD, CCH	5	150	2/1/0*	105	E					5												
3204	Elective	BD, CCH	5	150	2/1/0*	105	E						5											
3205	Elective	BD, CCH	5	150	2/1/0*	105	E							5										
4206	Elective	BD, CCH	6	180	2/1/1*	120	E													6				
AAP179	Educational practice	BD, UC	2		0/0/2		E			2														
<b>M-8. Basic training module for mineral processing</b>																								
MET501	Technological mineralogy	BD, UC	4	120	2/1/0	75	E	4																
MET185	Fundamentals of Mineral Processing (in English)	BD, UC	6	180	2/1/1	120	E				6													
MET502	Ore preparation processes and equipment	BD, UC	5	150	2/1/0	105	E					5												
MINS08	Fundamentals of mining technology	BD, UC	5	150	1/0/2	105	E					5												
MSM156	Metrology and standardization in the processing industry	BD, UC	5	150	2/0/1	105	E						5											
MET505	Gravitational enrichment methods	BD, UC	5	150	2/1/0	105	E						5											
MET186	General Metallurgy (in English)	BD, UC	5	150	2/0/1	105	E						5											
MET188	Chemistry of flotation reagents (in English)	BD, UC	4	120	2/0/1	75	E						4											
ERGS12	Power supply and electrical equipment of concentrating plants	BD, UC	5	150	2/0/1	105	E								5									
<b>CYCLE OF PROFILE DISCIPLINES (PD)</b>																								
<b>M-9. Module of professional activity on mineral enrichment</b>																								
MET181	Tail economy and sewage treatment of concentrating factories	PD, UC	5	150	1/1/1	105	E														5			
MET161	Assay and control of concentrating processes	PD, UC	5	150	1/1/1	105	E														5			
MET184	Exploitation and repair of concentrating equipment	PD, UC	6	180	1/1/1	120	E														6			
MET507	Flotation methods of enrichment	PD, UC	4	120	2/1/0	75	E														4			
<b>M-10. Professional activity module</b>																								
3301	Elective	PD, CCH	5	150	2/1/0*	105	E														5			
3302	Elective	PD, CCH	4	120	2/1/0*	75	E														4			





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

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

**CHANGE REGISTRATION SHEET**

Sequence number of the change	Section, paragraph of the document	Type of change (replace, cancel, add)	Number and date of notification	The change has been made	
				Date	Surname and initials, signature, position