



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

EDUCATIONAL PROGRAM

6B07212 – Recycling in metallurgy

Code and classification of the field of education:	6B07 - Engineering, manufacturing and construction industries
Code and classification of areas of study:	6B072 - Manufacturing and processing industries
Group of educational programs:	B071 – «Mining and extraction of minerals»
NQF level:	6
ORC level:	6
Training period:	4 years
Volume of loans:	240

Almaty 2025

The education program «6B07212 – Recycling in metallurgy» was approved at a meeting Academic Council of KazNRTU named after K.I. Satpayev.

Protocol № 4 dated «12» 12 2024 y.

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

Protocol № 3 dated «10» 12 2024 y.

The educational program «6B07212 – Recycling in metallurgy» was developed by the academic committee in the direction of «6B072 – Manufacturing and processing industries».

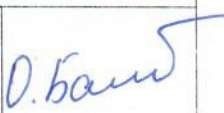
Full name	Academic degree/ academic title	Job title	Place of work	Signature
Chairman of the Academic Committee:				
Barmenshinova M.B.	c.t.s., associate professor	Head of the Department of MaMP	KazNRTU named after K.I. Satpayev	
Teaching staff:				
Baigenzhenov O.S.	PhD doctor, associate professor	Professor of the Department of MaMP	KazNRTU named after K.I. Satpaeva	
Koishina G.M.	PhD doctor, associate professor	Associate professor of the Department of MaMP	KazNRTU named after K.I. Satpaeva	
Employers:				
Ospanov E.A.	d.t.s.	Head of the Department of Complex processing of technogenic raw materials	«Kazakhmys Corporation» LLP	
Students:				
Asan M.D.	-	4 th year student	KazNRTU named after K.I. Satpayev	

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List of abbreviations and symbols

NJSC «Kazakh National Research Technical University named after K.I. Satpayev» - NJSC KazNRTU named after K.I. Satpayev;

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

MSaHE 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;

SDG - Sustainable Development Goals.

1. Description of the educational program

It is intended for the implementation of specialized bachelor's degree training in the educational program «6B07212 – Recycling in metallurgy» 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;

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

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

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

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

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

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

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

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

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

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

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

Introduction to the educational program. The development of an innovative economy initially forms the so-called double helices of interaction - between universities (science) and business, business and government, etc., which then form a «triple spiral». Within the framework of the triple helix model, interdisciplinary knowledge is generated, developed by interdisciplinary teams united for a short time to work on a specific problem of the real world. In the triple helix model, universities, along with educational and research functions, additionally increase entrepreneurial functions by actively participating in the cultivation of startups together with industry, stimulated by the state.

The concept of this scientific and educational program is based on the triple helix model, which involves the creation of innovative solutions based on interdisciplinary research and educational programs (Figure 1).



Figure 1 - The concept of scientific and educational programs

The previously established structure of education, based on in-depth training of specialists in narrowly focused specialization, has led to the emergence of interdisciplinary barriers and hindering the development of new "growth points" that are located at the junctions of disciplines.

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

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

The program is comprehensive and knowledge-intensive. The efficiency of using its results is of strategic importance for the republic.

The program is 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 advantages of the Program are:

- 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 the 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 «6B07212 – Recycling in metallurgy» includes fundamental, natural science, general engineering and professional training of bachelors in the field of secondary metallurgy and recycling of industrial and industrial waste in accordance with the development of science and technology, as well as the changing needs of the mining and metallurgical industry. A distinctive feature of the program is that the program gives the graduate adaptability to the manufacturing sector, due to the content of 40% of general engineering disciplines in the educational program. The graduate receives a fundamental set of general engineering disciplines, as well as the maximum set of specialized disciplines. The program provides in-depth study of the theory of metallurgical processes, theory and technology of preparation of technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical conversion, metallurgical heat engineering, furnace theory, design of metallurgical units, design of secondary metallurgy enterprises, physico-chemical analysis methods, recycling technology in ferrous and non-ferrous metals metallurgy, logistics of waste management. Graduates have knowledge of metallurgical technologies, including the stages of production and global recycling.

The mission of the educational program «6B07212 – Recycling in metallurgy»: preparation of bachelors in the field of secondary metallurgy and waste recycling, who know the methods of determining the quality of technogenic materials and secondary resources, methods of preparing technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical processing, technologies of their use and processing by metallurgical methods, who have fundamental training in physics, mathematics, chemistry, physico-chemical fundamentals of technologies of metallurgical processing of metal-containing non-traditional raw materials, environmental and economic aspects of the production of secondary ferrous and non-ferrous metals. 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 factories and factories, 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 engaged in the processing of man-made and secondary raw materials, as well as conduct research work to determine the quality of man-made materials and secondary resources, assess the complex impact of metallurgical technologies on the state of processes in the biosphere, study the circulation of elements in the technosphere and the formation of man-made deposits on territories of industrial enterprises, the study of sustainable, environmentally safe industrial development on the example of metallurgy, the development of environmentally friendly technologies and equipment for the use and processing of man-made materials and secondary resources, forecasting the output of main and associated products and the amount of emissions into the environment, assessing the social consequences of engineering solutions.

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 where, in addition to the main products, various metal-containing wastes are formed, branch research and design institutes, factory laboratories, secondary vocational and higher educational institutions.

The subjects of professional activity are technological processes and devices for processing technogenic and secondary raw materials and the production of metal products with increased consumer properties from them; processes of formation of technogenic deposits; processes and devices for ensuring energy and resource conservation and environmental protection during metallurgical operations; automatic control systems of metallurgical production, methods of analysis and quality control of final products.

Types of economic activity: material and energy saving during scrap metal recycling; global elemental flows of metals in the technosphere; movement of secondary metallurgical materials at a full-cycle enterprise; methods of environmentally safe use of technogenic energy resources in metallurgical production; secondary raw materials of ferrous and non-ferrous metals and its preparation for metallurgical processing; pyro- and hydrometallurgical technologies for processing secondary and technogenic raw materials ferrous and non-ferrous metals; hardware design for the production of secondary metals; auxiliary processes in the production of secondary metals; environmental and economic aspects of the production of secondary metals; methods and technological processes for the protection of the atmosphere and hydrosphere.

2. Purpose and objectives of the educational program

The purpose of the EP «6B07212 – Recycling in metallurgy» is:

– practice-oriented training of competitive and in-demand specialists in the field of secondary metallurgy and recycling of industrial and industrial waste for the mining and metallurgical complex of the Republic of Kazakhstan, who possess professional and personal competencies that allow them to carry out design, production, technological, scientific, technical, organizational and entrepreneurial activities at ferrous and non-ferrous metallurgy facilities with minimal damage to the environment and the rational use of natural resources.

The objectives of the OP «6B07212 – Recycling in metallurgy» are:

– combining the efforts of the university and industrial enterprises to conduct 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 urban objects, the principles of sustainable development of urbanized territories and measures of their organizational and legal support with the provision of true interdisciplinarity of education in these areas;

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

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

– fundamentals of the development and implementation of fundamental and applied scientific research and research and development work in the field of geological exploration and mineral processing, mining and metallurgy using new technological achievements, new generation equipment 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, an experimental base for the implementation of educational research, laboratory and coursework, production and pre-graduate practice;

– improving the level of educational and methodological work by creating new curricula, textbooks, teaching 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-tech innovative companies and other research centers;

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

– implementation of international cooperation in the field of 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;

- formation of theoretical and practical knowledge in technologies of processing of technogenic and secondary raw materials, knowledge in technologies of 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, waste disposal of metallurgical production and environmental restoration;

- formation of competencies in the field of metallurgical waste processing, taking into account economic efficiency and environmental safety.

The modern educational program allows you to specialize in:

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

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

- technological metallurgy is an industry where metal parts are designed and the processes under 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 creating environmentally friendly production, with sufficiently complete use of production waste and subsequent restoration of renewable natural resources, reducing environmental pollution, ensuring the integrated use of raw materials, environmental protection, resource, energy conservation and waste disposal.

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

B – basic knowledge, skills and abilities

B1 – to know the 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 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 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 work skills at enterprises for the processing of secondary and man-made raw materials and waste recycling.

B8 – to 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 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 in 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 Occupational safety and health 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 ways of processing secondary and man-made raw materials and waste recycling 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, metallurgical, machine-building, chemical 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 physico-chemical and metallurgical 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 secondary metallurgy.

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

P14 – the ability to identify metallurgical and chemical 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 secondary and man-made 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 gorenje and heat release, external and internal heat exchange in furnaces of various technological purposes, to choose rational temperature and thermal modes of operation of metallurgical furnaces. 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 pyro- and hydrometallurgical 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 conduct a feasibility study of the technological process. Plan the volume of production and perform calculations of the costs of production and sale of products, determine the break-even conditions. To carry out approximate calculations of harmful emissions and assessment of the ecological state of existing and projected technological processes and aggregates.

P24 – independence: independent work in typical situations and under guidance in 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 an 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 semi-finished products, 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 conditions of working situations: Conducting work on the organization of advanced technological processes, carrying out work on the development and introduction of new equipment, technologies and assortment, organizational and managerial work to improve product quality and production efficiency of mining and metallurgical, machine-building, chemical, etc. 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, machine-building, chemical, etc. industry, the introduction of new technologies.

Description of the mandatory standard requirements for graduation and awarding an academic bachelor's degree: mastering at least 240 academic credits of theoretical training and a final thesis.

Special requirements for graduation in this EP:

- 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 selection of the topics of the thesis (project) by students;

- 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 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	6B07212 – Recycling in metallurgy
5	Brief description of the educational program	The educational program "Recycling in Metallurgy" includes fundamental, natural science, general engineering and professional training of bachelors in the field of secondary metallurgy and recycling of industrial and industrial waste in accordance with the development of science and technology, as well as the changing needs of the mining and metallurgical industry.
6	Purpose of the EP	Practice-oriented training of competitive and in-demand specialists in the field of secondary metallurgy and recycling of industrial and industrial waste for the mining and metallurgical complex of the Republic of Kazakhstan, who possess professional and personal competencies that allow them to carry out design, production, technological, scientific, technical, organizational and entrepreneurial activities at ferrous and non-ferrous metallurgy facilities with minimal damage to the environment and the rational use of natural resources
7	EP type	New
8	NQF level	6
9	ORC level	6
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 - demonstrate skills in solving professional tasks using knowledge and methods of physical, mathematical, chemical sciences, computer technology software and networks in compliance with the basic requirements of information security and the introduction of digital communication processes in secondary metallurgy. Knowledge of methods of processing and disposal of metallurgical waste, aimed at minimizing the impact on the environment. LO2 - to use cognitive-linguistic-cultural methodology in oral and

		written forms in the state, Russian and foreign languages to solve the problems of communication in the multilingual and multicultural society of the Republic of Kazakhstan and communication in the international arena. LO3 - to carry out design work, to draw up design and technological documentation when choosing rational methods of complex processing of secondary and man-made raw materials and waste recycling, taking into account environmental protection requirements. LO4 - apply methods of scientific research and economic calculations, methods of physico-chemical analysis, calculation of chemical, physico-chemical processes and devices occurring and used in the processing of secondary and man-made raw materials and waste recycling. LO5 - to solve practical problems in the field of waste management, that is, to determine the quality of man-made materials and secondary resources, to choose technologies for their direct use or methods of their preliminary preparation for metallurgical processing and subsequent technological schemes of processing by metallurgical methods. LO6 - to have the skills to work on modern laboratory equipment and control and measuring equipment to conduct the necessary experiments in the production of ferrous and non-ferrous metals from secondary and man-made raw materials. LO7 - possess mathematical modeling skills and use experimental research to improve the efficiency of recycling processes; skills in analysis, synthesis, calculation and design of equipment and apparatuses in the planning and management of production in secondary metallurgy. LO8 - To build a personal educational trajectory and improve their knowledge in the field of secondary metallurgy and waste recycling throughout their professional activities.
13	Form of study	full-time
14	Training period	4 years
15	Volume of loans	240
16	Languages of instruction	Kazakh, russian, english
17	Awarded Academic Degree	Bachelor of engineering and technology in the educational program «6B07212 - Processing in Metallurgy»
18	Developers and authors:	Barmenshinova M.B. Moldabaeva G.Zh.

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	English is a compulsory subject. According to the results of placement test or IELTS score, students are placed into groups and disciplines. The name of the discipline corresponds to the level of English. When passing from level to level, prerequisites and postrequisites are respected.	10								
2	Kazakh (Russian) language	Kazakh (Russian) language In this course author considers socio-political, socio-cultural spheres of communication and functional styles of the modern kazakh (russian) language. The course covers the specifics of the scientific style to develop and activate professional communication skills and abilities of students. Also it allows students to leavn the basics of scientific style practically and develop the ability of production structural and semantic text analysis.	10								
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 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								
4	Information and Communication Technologies (in English)	The aim of the course is to gain theoretical knowledge in information processing, the latest information technologies, local and global networks, the methods of information protection; Getting the right use of text editor editors and tabulators; creation of base and different categories of applications.	5								
5	History of Kazakhstan	The purpose of the discipline is to provide objective historical knowledge about the main stages of the history of Kazakhstan from ancient times to the present day; to acquaint students with the problems of the formation and development of statehood and historical and cultural processes; to promote the formation of humanistic values and patriotic feelings in the student; to teach the student to use the acquired historical knowledge in educational, professional and everyday life; to assess the role of Kazakhstan in world history.	5								
6	Philosophy	The purpose of the discipline is to teach students the theoretical	5								

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		foundations of philosophy as a way of cognition and spiritual development of the world; developing their interest in fundamental knowledge, stimulating the need for philosophical assessments of historical events and facts of reality, assimilating the idea of unity of the world historical and cultural process while recognizing the diversity of its skills of applying philosophical and general scientific methods in professional activity.									
7	Socio-political knowledge module (sociology, political science)	The objectives of the disciplines are to provide students with explanations on the sociological analysis of society, about social communities and personality, factors and patterns of social development, forms of interaction, types and directions of social processes, forms of regulation of social behavior, as well as primary political knowledge that will serve as a theoretical basis for understanding socio-political processes, for the formation of political culture, the development of personal position and a clearer understanding of the measure of their responsibility; to help master the political-legal, moral-ethical and socio-cultural norms necessary for activities in the interests of society, the formation of personal responsibility and personal success.	3								
8	Socio-political knowledge module (culturology, psychology)	The purpose of the disciplines is to study the real processes of cultural activity of people who create material and spiritual values, to identify the main trends and patterns of cultural development, the change of cultural epochs, methods and styles, their role in the formation of a person and the development of society, as well as to master psychological knowledge for the effective organization of interpersonal interaction, social adaptation in the field of their professional activities.	5								
Cycle of general education disciplines Component of choice											
9	The base of anti-corruption culture and law	Purpose: to increase the public and individual legal awareness and legal culture of students, as well as the formation of a knowledge system and a civic position on combating corruption as an antisocial phenomenon. Contents: improvement of socio-economic relations of the Kazakh society, psychological features of corrupt behavior, formation of an anti-corruption culture, legal responsibility for acts of corruption in various fields.	5				V				V
10	Fundamentals of Economics and Entrepreneurship	Purpose: To develop basic knowledge of economic processes and skills in entrepreneurial activities. Content: The course aims to develop skills in analyzing economic concepts such as supply and demand, and market equilibrium. It includes the basics of creating and managing a business, developing business plans, risk assessment, and strategic decision-making.	5				V				V
11	Fundamentals of scientific research	Purpose: The goal of studying the discipline is to develop students'	5			V		V			V

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	methods	research skills; to introduce students to scientific knowledge, their readiness and ability to conduct research. Objectives of studying the discipline: to contribute to the deepening and consolidation of existing theoretical knowledge by students; to develop practical skills in conducting scientific research, analyzing the results obtained and developing recommendations; to improve methodological skills in independent work with information sources and appropriate software and hardware.									
12	Ecology and life safety	Purpose: formation of ecological knowledge and consciousness, obtaining theoretical and practical knowledge on modern methods of rational use of natural resources and environmental protection. Contents: the study of the tasks of ecology as a science, the laws of the functioning of natural systems and aspects of environmental safety in working conditions, environmental monitoring and management in the field of its safety, ways to solve environmental problems; life safety in the technosphere, emergencies of a natural and man-made nature.	5	V				V			
13	Basics of Financial Literacy	Purpose: formation of financial literacy of students on the basis of building a direct link between the acquired knowledge and their practical application. Contents: using in practice all kinds of tools in the field of financial management, saving and increasing savings, competent budget planning, obtaining practical skills in calculating, paying taxes and correctly filling out tax reports, analyzing financial information, orienting in financial products to choose adequate investment strategies.	5	V		V					
Cycle of basic disciplines University component											
14	Mathematics I	Purpose: to introduce students to the fundamental concepts of linear algebra, analytical geometry and mathematical analysis. To form the ability to solve typical and applied problems of the discipline. Contents_ Elements of linear algebra, vector algebra and analytical geometry. Introduction to the analysis. Differential calculus of a function of one variable. The study of functions using derivatives. Functions of several variables. Partial derivatives. The extremum of a function of two variables.	5	V				V			V
15	Mathematics II	Purpose: To teach students integration methods. To teach you how to choose the right method for finding the primitive. To teach how to apply a certain integral to solve practical problems. Contents_ integral calculus of the function of one and two variables, series theory. Indefinite integrals, methods of their calculation. Certain integrals and applications of certain integrals. Improper integrals. Theory of numerical and functional series, Taylor and Maclaurin series, application of series to approximate	5	V				V			V

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		calculations_										
16	Physics	Purpose: To form ideas about the modern physical picture of the world and scientific worldview, the ability to use knowledge of fundamental laws, theories of classical and modern physics. Contents_ physical fundamentals of mechanics, fundamentals of molecular physics and thermodynamics, electricity and magnetism, vibrations and waves, optics and fundamentals of quantum physics.	5			V						V
17	Engineering and computer graphics	Purpose: To develop students' knowledge of drawing construction and skills in developing graphical and textual design documentation in accordance with standards. Content: Students will study ESKD standards, graphic primitives, geometric constructions, methods and properties of orthogonal projection, Monge's projection, axonometric projections, metric tasks, types and features of connections, creating part sketches and assembly drawings, detailing, and creating complex 3D solid objects in AutoCAD.	5	V	V							V
18	Chemistry	Purpose: formation of knowledge on fundamental issues of general chemistry and skills of their application in professional activity. Summary Laws, theoretical propositions and conclusions that underlie chemical disciplines; properties and relationships of chemical elements based on the periodic law of D.I.Mendeleev and on modern ideas about the structure of matter; fundamentals of chemical thermodynamics and kinetics; processes in solutions; structure of complex compounds.	5			V						V
19	Physical chemistry	Purpose: to form students' abilities to understand the physico-chemical essence of processes and to use the basic laws of physical chemistry in complex industrial and technological activities. Contents: laws of thermodynamics; basic equations of chemical thermodynamics; methods of thermodynamic description of chemical and phase equilibria in multicomponent systems; properties of solutions; fundamentals of electrochemistry; basic concepts, theories and laws of chemical kinetics and catalysis.	5			V						V
20	Fundamentals of the specialty in secondary metallurgy	Purpose: This course is an introduction to metallurgy and helps the student to master the basic terms and definitions in metallurgy, general principles of technological process development, as well as the design and principles of operation of basic metallurgical units. Content: Characteristics of secondary raw materials, features of structure, forms of ferrous, non-ferrous and valuable metals. Modern methods of processing of secondary raw materials. New processes of additional extraction of non-ferrous and valuable metals from secondary raw materials. Selection and justification of methods of processing of secondary raw materials, economic analysis and evaluation of their	5		V	V		V				

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		possible processing. Waste-free, environmentally friendly technologies of secondary raw materials processing with complex extraction of valuable metals. SWOT-analysis of existing and new processes of recycling of secondary raw materials.									
21	General metallurgy	Purpose: To study the theoretical basis of methods of ore mining, beneficiation, preparation of raw materials for metallurgical processing and metallurgical processing of ferrous, non-ferrous and rare metal raw materials. Content: This course is an introduction to metallurgy and helps the student to master the basic terms and definitions in metallurgy, general principles of technological process development, as well as the design and principles of operation of basic metallurgical units.	6	V	V	V		V			
22	Fundamentals of metal science	Purpose: to study the structure, properties of metals, the relationship between the chemical composition, structure and properties of metals, as well as the regularity of changes in structure and properties under the influence of external factors. Content: Structure of metals, atomic-crystalline structure and crystal lattices of metals. Real structure of metal crystals, anisotropy of crystal properties. Defects in crystal structure. Methods of studying the structure of metals and alloys. Processes of crystallization, elastic and plastic deformation, recrystallization and melting of metals. Mechanical properties and destruction of metals. Fundamentals of kinetics of phase transformations in metal alloys, structure of alloys. State diagrams of double and ternary metallic systems	5			V		V			V
23	Theoretical foundations of metallurgical processes	Purpose: Formation of students' systematized knowledge about the basic metallurgical processes of processing of oxidized and sulfide mineral and technogenic raw materials, salt melts using high-temperature processes. Content: Laws, theoretical provisions and conclusions about the structure and properties of metallic, oxide, sulfide systems; thermodynamics and kinetics of processes of metallurgical processing of mineral and technogenic raw materials, salt melts; liquation and distillation processes of obtaining; methods of metal refining. The main directions of development of theory and practice of extraction and refining of metals taking into account the integrated use of raw materials and modern environmental requirements.	5			V		V			V
24	Production of ferrous and non-ferrous metal alloys from waste	Purpose: Studying the processes of obtaining ferrous and non-ferrous metal alloys from wastes Content: Basic smelting processes of non-ferrous and ferrous metal alloys includes theoretical, technological and constructive issues in the field of traditional and new metallurgy processes. Acquisition of competencies in analyzing metal production technologies, developing technological	5		V	V		V	V		

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		schemes and designs of metallurgical units and carrying out technological calculations.									
25	Bases of designing and details of cars	Purpose: to acquire knowledge of calculations and design of machine parts and assemblies, taking into account the criteria of strength, reliability and stability.Contents_ general principles of design and construction, construction of models and calculation algorithms for standard machine parts taking into account performance criteria, fundamentals of theory and methodology for calculating standard machine parts, computer technologies for designing assemblies and machine parts. Basic requirements for machine parts and assemblies_	5	V						V	V
26	Heat transfer and mass transfer in metallurgy	Purpose: study of heat transfer and mass transfer in metallurgy Content: Heat power engineering of sintering process. Heat power engineering of pellet roasting process. Heat power engineering of blast furnace process. Heat transfer in blast furnace. Heat transfer in the layer of lump materials. Factors influencing heat exchange processes. Heat power engineering of converter production. Laws of mass and heat transfer. Mass- and heat exchange in baths of steel-smelting units. Thermal balance of oxygen-converter melting. Thermal losses of converters. Influence of technological parameters on thermal operation of converters. Heat power engineering of electric steelmaking processes. Features of thermal operation of electric furnaces. Energy balances of electric furnaces. Features of thermal operation of ferroalloy furnaces.	5		V	V				V	
27	Design of secondary metallurgy enterprises	Purpose: formation of students' knowledge in the field of scientific principles of organization of technological design and construction of metallurgical facilities taking into account the requirements of modern regulatory documents Content: Design of metallurgical facilities and secondary metallurgy enterprises for the development and / or drawing up design and estimate documentation for the construction of new and / or changes to existing metallurgical facilities during their expansion, modernization, technical re-equipment, reconstruction, restoration, overhaul, conservation, post-utilization. Design of metallurgical facilities taking into account the provisions of current legislation and state regulations in the field of architectural, town-planning and construction activities.	4						V	V	V
28	Theory and technology of non-coke metallurgy	Purpose: To study the theory and technology of coke-free metallurgy Content: This course covers the scientific basis of coke-free metallurgy processes. Experimental and industrial technologies of metal production in rotary and shaft furnaces, in fluidized bed and in melt are described. The issues of production of final metal from metallized raw materials, as well as the production of reducing gases are considered.	5			V			V		V
Cycle of basic disciplines											

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Component of choice											
29	ESG principles in inclusive culture	Purpose of the course: It focuses on studying ESG (Environmental, Social, Governance) principles and their interaction with the creation of an inclusive culture within an organization. Content: Students will gain knowledge on how implementing ESG principles contributes to corporate social responsibility, sustainable development, and equal opportunities for all employees, including those who may face various forms of discrimination. The course will help students understand the importance of an inclusive culture in achieving long-term business goals and ensuring sustainable organizational development.	5		V	V					V
	Theory and technology of preparation of technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical processing	Purpose: to form students' knowledge about the ways of education, characteristics and properties of secondary raw materials of ferrous and non-ferrous metallurgy; to transfer the basics of knowledge in the field of preparation of man-made and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical redistribution, as well as skills in solving practical problems related to future professional activities. Contents: Ferrous and non-ferrous metallurgy waste: general classification and types of waste. Collection and harvesting of metal-containing secondary and man-made raw materials. Pyrotechnic and radiation control of metal-containing secondary and man-made raw materials. Sorting of scrap and waste. Sorting equipment. Screening and classification of metal-containing raw materials. Separation of fragments and waste. Theoretical foundations of crushing, crushing and crushing of scrap and waste. Special separation methods. Collection of scrap and waste. Separation of scrap and waste. Methods for removing moisture and fat from lumpy waste. Dehydration and drying of raw materials and products of primary processing of metal-containing secondary and man-made raw materials. Storage and testing of secondary raw materials. Auxiliary equipment for the primary processing of metal-containing secondary and man-made raw materials. Safety precautions in the primary processing of metal-containing secondary and man-made raw materials.	5				V	V			
30	Recycling of fine industrial waste	Purpose: To form students' knowledge of technological features of metallurgy of technogenic raw materials; modern processes of production of non-ferrous and ferrous metals from technogenic waste, providing integrated use of raw material constituents, environmental protection, resource and energy saving and waste elimination. Content: Market of technogenic fine dispersed materials. Finely dispersed solid domestic and industrial wastes. Ash and slag waste. The concept of "shredding" technologies. Shredders. Composition and metallurgical characteristics of "shredding" dusts. Slag, "heavy" and "light" fractions of shredding dust. Development and prospects of shredding technology.	5		V	V		V			

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		Compacting, briquetting, pelletizing of finely dispersed technogenic materials. Role of ash and sludge collectors in the structure of a modern enterprise of ferrous metallurgy. Technologies of sludge processing: current state and prospects. Agglomeration and production of pellets using technogenic and secondary materials.									
31	Wastewater treatment processes and devices	Purpose: Study of technology and processes and apparatuses for wastewater treatment. Content: Properties and classification of water by purpose. Issues of ecological safety of hydrosphere. Basics of water utilization in recycling and closed water supply systems of enterprises, as well as mechanical, chemical, physico-chemical, biochemical and thermal methods of removing soluble and insoluble polluting impurities from industrial wastewater. The basic design of apparatuses, plants and facilities for wastewater treatment of suspended and dissolved impurities. Structural calculation of apparatuses used in wastewater treatment: settling tanks, filters, flotators, adsorbers, electrolyzers, extractors, rectification plants, aeration tanks and biofilters.	5	V	V			V			
32	Physical and chemical methods of the analysis	The purpose of the course is to teach students how to use Physico-chemical methods of analysis to study the properties and composition of new inorganic materials and substances. The main types of physico-chemical methods of analysis are considered: spectral, electrochemical, chromatographic. The theoretical principles of the methods, the device and principles of operation of analytical equipment, methods of computer processing of experimental results are described.	5			V					V
33	Continuous casting of steel	Purpose: To study the process of producing ingots from liquid steel (for rolling, forging or pressing) Content: The importance of foundry tasks for obtaining high quality metal. Factors affecting the technical and economic performance of production and quality, steel and electric fireplaces. Brief description of the main methods of casting. Basic physico-chemical, thermal and hydrodynamic problems of the discipline under study are considered. The concept of crystallization and solidification. Theory of casting metals and alloys. Casting technologies of metals and alloys.	5		V	V					V
34	Recycling technologies in the metallurgy of rare metals	Purpose: Study of recycling technology in the metallurgy of rare metals Content: Characterization of wastes containing rare metals. Recycling of wastes of molybdenum, tungsten and niobium alloys using oxidizing methods, electrochemical methods and halogenation methods. Extraction of rhenium from fine and lump waste of heat-resistant nickel alloys. Recycling of electronic equipment scrap containing rare metals using pyro-, hydrometallurgical technologies. Recycling of waste tungsten steels and hard alloys with processing of lump waste (scale, chips, edge	5	V		V			V		

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		trimmings after rolling, unused parts of tool plates, their fragments, defective products of production, etc.) and dust-like abrasive materials (dust from sharpening of carbide tools). Extraction of indium from secondary raw materials by amalgam method. Recycling of gallium-containing radioelectronic and electronics waste, processing of gallium arsenide waste by thermal dissociation, alloying with alkali in the presence of oxidizer, chlorination with subsequent rectification. Recycling of deactivated molybdenum-nickel, platinum-rich catalysts. Extraction of rhenium, molybdenum and tungsten from various solutions of hydrometallurgical processing of ore, technogenic and secondary raw materials. Extraction of germanium from dusts generated during processing of copper and zinc concentrates, from dusts of gas plants.									
35	Fundamentals of sustainable development and ESG projects in Kazakhstan	Purpose: the goal is for students to master the theoretical foundations and practical skills in the field of sustainable development and ESG, as well as to develop an understanding of the role of these aspects in the modern economic and social development of Kazakhstan. Contents: introduces the principles of sustainable development and the implementation of ESG practices in Kazakhstan, includes the study of national and international standards, analysis of successful ESG projects and strategies for their implementation in enterprises and organizations.	5	V				V	V		
36	Ecology of the metropolis	Purpose: Study of the main environmental problems faced by megacities, problems of environmental pollution. Content: Assessment of the state of the natural environment under global changes; the main stages of civilization development and environmental crises typical for each of them; principles of careful attitude to nature and sustainable development of civilization; methodology of field and laboratory environmental research. Analysis of ecological processes and phenomena; formation of ecological outlook on the basis of using the provisions of the concept of sustainable development	5	V					V		
37	Theory and technology of steelmaking processes	Purpose: to provide knowledge on the theoretical foundations of steel production, the processes occurring during steel smelting, steel production in converters and hearth processes of steel production, out-of-furnace processing and casting of steel. Contents: Prospects for the development of steelmaking. The concept of steel, the classification of steel by purpose, quality, composition, behavior in molds, production method. Marking of steels. The general scheme of production. Methods of deoxidation of steel, advantages and disadvantages. Features of alloy steel smelting. The effect of alloying elements on the properties of steel. Direct alloying. Development of converter steel production. Production of steel in continuous steelmaking units.	5		V	V		V			

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38	Legal regulation of intellectual property	Purpose: the goal is to form a holistic understanding of the system of legal regulation of intellectual property, including basic principles, mechanisms for protecting intellectual property rights and features of their implementation. Content: The discipline covers the basics of IP law, including copyright, patents, trademarks, and industrial designs. Students learn how to protect and manage intellectual property rights, and consider legal disputes and methods for resolving them.	5	✓	✓		✓	✓			
39	Debusting facilities and condensation in metallurgy	Purpose: to form students' knowledge of theoretical principles of operation, design features and performance of apparatus and schemes of installations for dust collection and condensation of vapors of metals and their compounds. Content: The course "Dust collection and condensation in metallurgy" aims to acquire knowledge and skills to work with dust collection and condensation equipment in metallurgy. Students should know the theoretical and technological regularities of dust removal of particles processed in pyrometallurgical processes of materials depending on humidity, temperature, gas flow, coarseness, as well as technological parameters in the condensation of vapors of metals and their compounds.	5		✓			✓			
40	Special electrometallurgy	Purpose: to form students' knowledge in the field of theoretical and applied electrochemistry aimed at obtaining and refining non-ferrous metals. Contents: The history of development and the main provisions of theoretical and applied electrochemistry. The essence of the operation of a galvanic cell and an electrolysis bath. Faraday's laws. Coulometers. Electrode potentials. The EMF of the galvanic cell. Classification of electrodes. Electrocapillary and electrokinetic phenomena. Electrochemical and diffusion kinetics. The joint discharge of ions. Electrocrystallization of metals at the cathode. Kinetics of anodic dissolution of metals. Physico-chemical bases of electrolysis of aqueous solutions and molten media. Electroplating coatings using rare metals. Electrofining and electrodeposition of copper from aqueous solutions of copper sulfate. Electrolysis of nickel. Electroextraction of zinc and lead. Electrolytic production of aluminum from cryolytic alumina melt. Electrolytic production of magnesium and sodium. Electrolysis of refractory rare metals. Electrolysis of gold and silver. Prospects for the application of electrolysis in modern metallurgy	5			✓		✓	✓		
41	Fundamentals of Artificial Intelligence	Purpose: to familiarize students with the basic concepts, methods and technologies in the field of artificial intelligence: machine learning, computer vision, natural language processing, etc. Contents: general definition of artificial intelligence, intelligent agents,	5			✓		✓	✓		

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		information retrieval and state space exploration, logical agents, architecture of artificial intelligence systems, expert systems, observational learning, statistical learning methods, probabilistic processing of linguistic information, semantic models, natural language processing systems.										
42	Recycling of waste and secondary raw materials of precious metals	Purpose: Study of waste and secondary raw materials of noble metals Content: Classification and characterization of secondary and technogenic raw materials containing noble metals. Main methods of processing of silver-, gold-, platinum-containing raw materials. Pyro- and hydrometallurgical methods of obtaining secondary refined metals and semi-finished products for processing enterprises.	6		V			V	V			
43	Metallurgical furnaces	Purpose: To study the processes of foundry, metal melting, mold making, metal pouring into molds and cooling, knocking out, cleaning, chipping of castings, heat treatment and quality control of castings. Content: A brief overview of the history of the development of molding technology of castings. The structure of casting production and the use of different technologies. The sequence of making a single casting mold. Schemes of technological processes of casting production. Basic concepts and terms. The structure of casting production using different technologies. General technological schemes of casting production. Types of foundry production.	6		V	V		V				
Cycle of profile disciplines University component												
45	Metals and their compounds	The purpose of the discipline is to study the physical and chemical properties of metals, their compounds and alloys, their ores, deposits, distribution in nature. The main methods of obtaining, as well as the use of metals, their compounds and alloys in science and technology. Content: General information about metals. Familiarization with the history of metallurgy, general concepts and definitions of metal compounds. Classification of non-ferrous and ferrous metals, the place and importance of metals in the general classification of inorganic substances. Characteristics of metal groups, the prevalence of metals in nature. Physical and chemical properties of ferrous and non-ferrous metals, characteristics of typical metals of the Periodic System of Elements D.I. Mendeleev. Laws of chemical reactions involving metals and their compounds: hydrolysis, electrolysis, redox processes. Applications of the most important metals and their compounds.	4		V	V		V				
46	Technology of metallurgical processes	Purpose: Studying the basic production technology of metallurgy of ferrous and non-ferrous metals and physical and chemical characteristics of various metallurgical products: slags, melts, matte, oxides, etc., as well as the characteristics of the main types of equipment of metallurgical	5			V		V	V			

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		plants. Content: Structure, raw material base and products of metallurgical production. Methods of preparation of raw materials for metallurgical processing. Theoretical foundations of the processes. Principles of development of technology for the production of ferrous and non-ferrous metals. Technologies of production of pig iron and steel, out-of-furnace treatment of metal melts. Technology of ferroalloys production. Basic processes and apparatuses of non-ferrous metallurgy. Traditional and modern technologies for the production of copper, zinc, aluminum. Production technologies of titanium and tungsten.									
47	Econometric modeling of metal recycling	Цель: Данный курс является обобщением знаний студентов по специальным дисциплинам, а также экономико-математическим описанием технологических процессов для проведения экспериментов и изучения их на модели Содержание: Основные типы эконометрических моделей и методы их построения; область применения современного эконометрического моделирования методы математического моделирования применительно к процессам переработки минерального, вторичного и техногенного сырья; методика составления математического описания химических и физических процессов, динамики жидкостей и газов, передачи тепла. Методы идентификации. Методы разработки информационных баз данных. Визуализация и анимация моделей	5	V					V	V	
48	Modern ecological schemes and forecasting in metallurgy	Purpose: Formation of knowledge in the field related to the creation of environmentally friendly metallurgical production, existing low-waste and environmentally friendly technologies of production of ferrous and non-ferrous metals. Content: The main factors of impact of metallurgy on the environment. Consumption of primary and secondary resources. Saving of materials and energy. General principles of creation of ecologically clean metallurgy and requirements to it. Formation of ecological strategy at full cycle plants. Classification of man-made resources. Payment for environmental pollution. Assessment of ecological damage. Ecological and economic efficiency. Main tasks, objects, methods and classification of environmental monitoring system. Environmental management system. Environmental certification. Basic provisions of the series of standards and certification for compliance with ISO 14000 standards.	6	V		V		V			
49	Equipment of metallurgical shops	Purpose: Study of main and auxiliary equipment for preparation of raw materials for metallurgical processing and its transportation, equipment for pyrometallurgical, hydrometallurgical and electrometallurgical processes and for dust and gas purification. Content: Machines and units	4	V						V	

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		for preparation of charge materials for blast furnace smelting. Bowl pelletizers of charge materials. Blast furnace shop. Skip winches. Machines and units of steelmaking production. Machines and units of oxygen-converter shops. Smelting furnaces. Horizontal converters. Scrubbers. Equipment for metal casting. Carousel casting machines. Carousel casting machines for zinc casting. Equipment for fire refining of copper.									
Cycle of profile disciplines Component of choice											
50	Technology of waste disposal and disposal in industry	Purpose: Studying the technology of utilization and disposal of waste in industry Content: The main environmental problems of production and consumption of ferrous and non-ferrous metals. Hazard classes of toxic wastes in metallurgy. Characteristics and classification of industrial waste. The main methods of utilization, neutralization and disposal of waste in industry. Utilization and neutralization of gases containing fluorine, chlorine, mercury, sulfur compounds and other harmful substances. Storage and disposal of industrial waste. Processing and utilization of industrial waste according to full factory technology.	5	V						V	
51	Fundamentals of metallurgical production design	Purpose: to form students' knowledge in the field of scientific principles of the organization of technological design and construction of metallurgical facilities, taking into account the requirements of modern regulatory documents, current instructions regulating a high level of standardization and unification of standard projects and new design solutions for the organization of planning and development of the territory of an industrial area in the structure of the city, the territory of a metallurgical facility, industrial buildings and building structures. Contents: General information about the design. The design stages of industrial facilities. Pre-project documentation. The composition of the design and estimate documentation. The initial data for the design. Technological design of metallurgical facilities. Selection and justification of the hardware and technological scheme for the production of commercial metals or its compounds in metallurgical plants. Selection and calculation of equipment for metallurgical plants. Introduction to the architectural and construction design of industrial facilities. The placement of enterprises in the structure of the city, their classification, grouping and formation of industrial areas and nodes. Spatial planning formation of the building of the factory territory. Building methods. Types of construction objects. Entrances and entrances to industrial facilities. Construction of the pre-factory territory. Highways and driveways. Gaps between buildings and structures. Design of industrial	5	V						V	V

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		buildings. The main structural elements of industrial buildings. Transportation of metallurgical facilities. Engineering networks and communications of metallurgical facilities. Landscaping, elements of monumental and decorative art and visual information in industrial enterprises.									
52	Logistics of waste management	Purpose: Study of the development of methodology and logistics in waste management, both at the level of the organization and at the level of territorial entities. Contents: Terms, definitions and classification of waste. Legal regulation in the field of waste management in the countries of the European Union. Classification catalog of waste. Legal regulation of waste management activities in Kazakhstan. General strategy in waste management. Organization of a system for collecting solid, liquid and gaseous industrial waste. Use of production and consumption waste as secondary resources in the production of ferrous and non-ferrous metals. Thermal treatment of waste. Placement of waste in landfills.	4					V	V		
53	Modeling of metallurgical processes	Purpose: Studying the methodology of modeling of metallurgical processes Content: The concept of models and modeling, systems and their characteristics, theory and similarity criteria for modeling processes; methods of identification, methods of development of information databases and visualization of models.	4	V					V	V	
54	Recycling technologies in foundry production	Purpose: To study recycling technology in foundries Content: Technogenic foundry raw materials: steel and cast iron scrap of complex composition. Metallurgical dust and briquettes. Metalworking waste: shavings, trimmings, scale, including oil-containing ones. Melting in a cupola with the injection of metal-containing fine materials. Capture of zinc, lead, tin, germanium and other valuable impurity elements. Steel and cast iron casting from a charge with a high content of impurity elements. Modern trends in the development of technology for melting in a cupola for processing man-made and secondary raw materials.	6			V		V	V		
55	Recycling technologies in the production of steel	Purpose: To study recycling technology in steel production Content: Movement of secondary metallurgical materials in a full-cycle enterprise. Trim, scale. Welding slag of rolling shops. Steel and cast iron scrap. Processing of scrap metal from coated parts, including organic materials, in steelmaking units. Steelmaking slags, slurries and dusts: microprime composition, methods of safe storage and storage, processing in converters and hearth steelmaking units. Influence of scrap metal quality on steel smelting technology in open-hearth furnaces, oxygen converters and electric arc furnaces. Features of the use of technogenic raw materials in steelmaking mini-factories. Requirements for charge	6			V		V	V		

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		materials and waste. Special technologies and units for processing scrap metal and metallurgical dusts.									
56	Processes and devices for processing waste and secondary raw materials	Purpose: To study the processes and apparatuses of waste and secondary raw materials processing Content: Organization of collection, storage, delivery of scrap and waste of ferrous and non-ferrous metals, sources of their formation and directions of use. The main equipment for the primary processing of waste and secondary raw materials of ferrous and non-ferrous metals: sorting of scrap and waste, cutting and compacting of scrap and waste, separation of scrap and waste, storage and testing of secondary raw materials and waste. Auxiliary equipment for primary processing of waste and secondary raw materials of ferrous and non-ferrous metals. Equipment for metallurgical processing of waste and secondary raw materials of ferrous and non-ferrous metals: melting units, refining units. Auxiliary equipment of metallurgical processing.	5		V	V		V			
57	Digitalization of secondary metallurgy enterprises	Purpose: Studying the construction of digital systems for different levels of production management at secondary metallurgy enterprises. Content: Analysis of the structure, functional and supporting parts of digitalization, methodological basis for the construction of digital technologies. The role of digital technologies in improving the economic mechanism of management at the enterprises of secondary metallurgy, as well as the construction of their information support. Application of digital technologies to optimize processes in order to reduce the risk of injury to people working in hazardous areas. Management of technological processes and maintenance of secondary metallurgy enterprises through the use of intelligent analytical software packages and control in an integrated way.	5		V				V		V
58	Recycling of waste from metallurgical industries	Purpose: Study of recycling of non-metallurgical wastes Content: Peculiarities of fuel and energy industry waste utilization. Composition and metallurgical properties of coal preparation and oil refining wastes, energy ashes and slags. Compacting, transportation, storage and preparation for metallurgical processing. Modern processing technologies, including metallurgical, their advantages and disadvantages. Transportation waste utilization. Special requirements of advanced industrialized countries to the processing of transportation wastes. Wastes containing lead, materials with organic coatings, plastics of complex composition. Disposal of medical waste. Morphological and chemical composition, toxicity, metallurgical characteristics. Halogens: iodine, fluorine, chlorine; their behavior in metallurgical systems. Processing of food and medical wastes in the sintering process. Special metallurgical technologies, PYROXEL process. Utilization of wastes of the first class	5		V	V		V			

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		of hazard. Modern requirements for processing and classification of toxic wastes.									
59	Consumer properties of metallurgical products	Purpose: formation of systematic knowledge, skills and abilities on consumer properties, technology requirements, physical and chemical properties and demand for metallurgical products of various metallurgical processing, on the main methods of management and quality control of metallurgical products. Course content: Classification of metallurgical products, quality control methods, requirements for consumer properties of metallurgical products, fixed in the system of standardization and certification, specifics of consumer properties of metallurgical products obtained from secondary and man-made raw materials. Methods and technologies used for the process of management and quality control of metallurgical products obtained from secondary and man-made raw materials	5	V				V	V		
60	Recycling technologies in heavy non-ferrous metals metallurgy	Purpose: Studying the technology of heavy non-ferrous metals recycling, methods of waste processing for the purpose of reuse of the obtained raw materials. Content: Secondary raw materials of heavy non-ferrous metals. Preparation of secondary raw materials of heavy non-ferrous metals for metallurgical processing. Basics and methods of pyro- and hydrometallurgical processing of secondary raw materials of heavy non-ferrous metals. Apparatus design of obtaining secondary heavy non-ferrous metals. Technology of processing waste and secondary raw materials of lead, copper, zinc, nickel. Auxiliary processes in the production of secondary heavy non-ferrous metals. Ecological and economic aspects of production of secondary heavy non-ferrous metals.	5			V		V	V		
61	Recycling technologies in light metal metallurgy	Purpose: To study recycling technology in light metal metallurgy Content: Sources of raw materials and characteristics of commercial products of secondary aluminum, titanium and magnesium enterprises. Processes of primary and metallurgical processing of scrap, waste aluminum, titanium and magnesium and the equipment used in this process. Fundamentals of design of technological schemes of workshops and plants for the production of secondary light metals, issues of economy, ecology, waste disposal and labor protection.	5			V		V	V		
62	Technologies for processing ferrous and non-ferrous metallurgy slags	Purpose: Studying the technology of processing slags of ferrous and non-ferrous metallurgy. Content: Characteristics of slags and their properties. Methods of blast furnace slag processing. Processing of steelmaking and ferroalloy slags. Technologies for processing non-ferrous metallurgy slags. Application of slags in metallurgy. Use of slags in the construction industry.	4		V			V		V	
63	Technologies of extraction of rare	Purpose: To study the technology of rare metals extraction from	4		V			V		V	

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	metals from secondary raw materials	secondary raw materials Content: Technologies for the extraction of zirconium, hafnium, tungsten, tantalum and niobium from various types of secondary raw materials: metal waste, refractory scrap, waste and scrap of hard alloys, shock-absorbing scrap of capacitors. The role of technogenic and secondary resources in the production of rare scattered elements. Technologies for the extraction of rhenium, germanium, gallium from secondary and man-made raw materials.									
64	Receipt, the quality and certification of by-products in the process of recycling	Purpose: to form students' systematic knowledge about the basics, technological features and hardware design of the main pyrometallurgical processes - roasting, smelting of ore and secondary raw materials and refining of metals. Contents: Features of metallurgical processes during smelting "for slag". Blast furnace melting using man-made materials and the production of slag of a given composition. Patterns of mass transfer between metal and slag. Formation of neutral compositions of "vagrant" elements. Associated products of coke chemical production. The use of finely dispersed carbon-containing technogenic materials in the production of coke. Slag processing. Glazing of potentially dangerous and toxic compounds. Production of metallurgical gases of a given composition using man-made raw materials. Quality and certification of associated products.	5	V				V	V		
65	Fundamentals of scientific research in secondary metallurgy	Purpose: To learn the fundamentals of scientific research in secondary metallurgy Content: Definition of the concept of "science". Stages of development of metallurgical science in Kazakhstan. Organization of scientific research in the Republic of Kazakhstan. Forms of R&D and R&D, their significance. Methodological foundations of scientific knowledge. Processing and storage of scientific information. Stages of scientific research. Sampling and sample preparation, setting up a metallurgical experiment. Types and classification of scientific documentation. Errors, errors and their exclusion, correlation analysis of experimental data. Preparation of scientific documentation, presentation of research results. Efficiency and implementation of scientific developments. Directions of research in secondary metallurgy.	5			V		V	V		

5 Curriculum of the educational program

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"KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY NAMED AFTER K.I. SATBAYEV"



«APPROVED»
Decision of the Academic Council
NPJS C«KazNRTU
named after K.Satbayev»
dated 06.03.2025 Minutes № 10

WORKING CURRICULUM

Academic year

2025-2026 (Autumn, Spring)

Group of educational programs

B071 - "Mining and mineral extraction"

Educational program

6B07212 - "Recycling in metallurgy"

The awarded academic degree

Bachelor of engineering and technology

Form and duration of study

full time - 4 years

Discipline code	Name of disciplines	Block	Cycle	Total ECTS credits	Total hours	lek/lab/pr Contact hours	in hours SIS (including TSIS)	Form of control	Allocation of face-to-face training based on courses and semesters								Prerequisites	
									1 course		2 course		3 course		4 course			
									1 sem	2 sem	3 sem	4 sem	5 sem	6 sem	7 sem	8 sem		
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)																		
M-1. Module of language training																		
LNG108	Foreign language		GED, RC	5	150	0/0/45	105	E	5									
LNG104	Kazakh (russian) language		GED, RC	5	150	0/0/45	105	E	5									
LNG108	Foreign language		GED, RC	5	150	0/0/45	105	E		5								
LNG104	Kazakh (russian) language		GED, RC	5	150	0/0/45	105	E		5								
M-2. Module of physical training																		
KFK101	Physical culture I		GED, RC	2	60	0/0/30	30	E	2									
KFK102	Physical culture II		GED, RC	2	60	0/0/30	30	E		2								
KFK103	Physical culture III		GED, RC	2	60	0/0/30	30	E			2							
KFK104	Physical culture IV		GED, RC	2	60	0/0/30	30	E				2						
M-3. Module of information technology																		
CSE677	Information and communication technology		GED, RC	5	150	30/15/0	105	E			5							
M-4. Module of socio-cultural development																		
HUM137	History of Kazakhstan		GED, RC	5	150	15/0/30	105	GE		5								
HUM134	Module of socio-political knowledge (cultural studies, psychology)		GED, RC	5	150	30/0/15	105	E			5							
HUM132	Philosophy		GED, RC	5	150	15/0/30	105	E				5						
HUM120	Module of socio-political knowledge (sociology, political science)		GED, RC	3	90	15/0/15	60	E				3						
M-5. Module of anti-corruption culture, ecology and life safety base																		
CHE656	Ecology and life safety	1	GED, CCH	5	150	30/0/15	105	E				5						
MNG489	Fundamentals of economics and entrepreneurship	1	GED, CCH	5	150	30/0/15	105	E				5						
PET519	Fundamentals of scientific research methods	1	GED, CCH	5	150	30/0/15	105	E				5						
HUM136	Fundamentals of anti-corruption culture and law	1	GED, CCH	5	150	30/0/15	105	E				5						
MNG564	Basics of Financial Literacy	1	GED, CCH	5	150	30/0/15	105	E				5						
CYCLE OF BASIC DISCIPLINES (BD)																		
M-6. Module of physical and mathematical training																		
MAT101	Mathematics I		BD, UC	5	150	15/0/30	105	E	5									

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PHY468	Physics		BD, UC	5	150	15/15/15	105	E	5								
MAT102	Mathematics II		BD, UC	5	150	15/0/30	105	E		5							MAT101
M-7. Module of basic training																	
GEN429	Engineering and computer graphics		BD, UC	5	150	15/0/30	105	E	5								
CHE494	Chemistry		BD, UC	5	150	15/15/15	105	E		5							
AAP173	Practical training		BD, UC	2				R		2							
METS15	Theory and technology of preparation of technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical processing	1	BD, CCH	5	150	30/15/0	105	E			5						
METS20	Recycling of fine industrial waste	1	BD, CCH	5	150	30/0/15	105	E			5						
CHE127	Physical chemistry		BD, UC	5	150	15/15/15	105	E				5					
MET631	Wastewater treatment processes and devices	1	BD, CCH	5	150	30/15/0	105	E				5					
CHE593	Physical and chemical methods of the analysis	1	BD, CCH	5	150	30/15/0	105	E				5					
MET408	Continuous casting of steel	1	BD, CCH	5	150	30/15/0	105	E					5				MET413, MET430, MET454
MET634	Recycling technologies in the metallurgy of rare metals	1	BD, CCH	5	150	30/0/15	105	E					5				
MNG563	Fundamentals of sustainable development and ESG projects in Kazakhstan	1	BD, CCH	5	150	30/0/15	105	E					5				
CHE950	ESG principles in inclusive culture	1	BD, CCH	5	150	30/0/15	105	E					5				
MET651	Ecology of the metropolis	1	BD, CCH	5	150	30/0/15	105	E						5			
METS13	Theory and technology of steelmaking processes	1	BD, CCH	5	150	30/0/15	105	E						5			
MNG562	Legal regulation of intellectual property	1	BD, CCH	5	150	30/0/15	105	E						5			
MET143	Dedusting facilities and condensation in metallurgy	2	BD, CCH	5	150	30/0/15	105	E						5			MET140, MET117, MET123
METS18	Special electrometallurgy	2	BD, CCH	5	150	30/0/15	105	E						5			
CSE831	Fundamentals of Artificial Intelligence	2	BD, CCH	5	150	15/0/30	105	E						5			
MET695	Recycling of waste and secondary raw materials of precious metals	1	BD, CCH	6	180	30/0/30	120	E							6		
MET147	Metallurgical furnaces	1	BD, CCH	6	180	30/0/30	120	E								6	MET240, MET123, MET1461
M-8. Basic training module on metal recycling																	
MET454	General metallurgy		BD, UC	6	180	30/0/30	120	E				6					MET163, CHE192
MET627	Fundamentals of the specialty in secondary metallurgy		BD, UC	5	150	30/0/15	105	E				5					
MET628	Fundamentals of metal science		BD, UC	5	150	30/0/15	105	E					5				
MET639	Theoretical foundations of metallurgical processes		BD, UC	5	150	30/0/15	105	E						5			
MET629	Production of ferrous and non-ferrous metal alloys from waste		BD, UC	5	150	30/15/0	105	E						5			
GEN125	Bases of designing and details of cars		BD, UC	5	150	15/15/15	105	E						5			
MET640	Heat transfer and mass transfer in metallurgy		BD, UC	5	150	30/15/0	105	E						5			
MET633	Design of secondary metallurgy enterprises		BD, UC	4	120	30/0/15	75	E							4		
METS66	Theory and technology of non-coke metallurgy		BD, UC	5	150	30/0/15	105	E							5		
CYCLE OF PROFILE DISCIPLINES (PD)																	
M-9. Module of professional activity on metal recycling																	
MET135	Metals and their compounds		PD, UC	4	120	30/0/15	75	E	4								PHY111, CHE192, CHE199

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TEC481	Equipment of metallurgical shops		PD, UC	4	120	30/0/15	75	E						4			
MET123	Technology of metallurgical processes		PD, UC	5	150	30/0/15	105	E						5			PHY111, MAT101, CHE1923, CHE199
MET632	Econometric modeling of metal recycling		PD, UC	5	150	30/15/0	105	E						5			
MET498	Modern ecological schemes and forecasting in metallurgy		PD, UC	6	180	30/0/30	120	E						6			MET429
M-10. Professional activity module																	
AAP102	Production practice I		PD, UC	2				R					2				
AAP183	Production practice II		PD, UC	3				R						3			
MET638	Technology of waste disposal and disposal in industry	1	PD, CCH	5	150	30/0/15	105	E						5			
MET575	Fundamentals of metallurgical production design	1	PD, CCH	5	150	30/0/15	105	E						5			
MET136	Modelling of metallurgical processes	2	PD, CCH	4	120	30/0/15	75	E						4			MET123, MAT103, GEN111
MET650	Logistics of waste management	2	PD, CCH	4	120	30/0/15	75	E						4			
MET540	Recycling technologies in foundry production	1	PD, CCH	6	180	30/0/15	135	E							6		
MET535	Recycling technologies in the production of steel	1	PD, CCH	6	180	30/15/0	135	E							6		
MET636	Processes and devices for processing waste and secondary raw materials	2	PD, CCH	5	150	30/0/15	105	E							5		
MET637	Digitalization of secondary metallurgy enterprises	2	PD, CCH	5	150	30/0/15	105	E							5		
MET525	Recycling of waste from metallurgical industries	1	PD, CCH	5	150	30/0/15	105	E								5	
MET590	Consumer properties of metallurgical products	1	PD, CCH	5	150	30/0/15	105	E								5	
MET545	Recycling technologies in heavy non-ferrous metals metallurgy	2	PD, CCH	5	150	30/15/0	105	E								5	
MET550	Recycling technologies in light metal metallurgy	2	PD, CCH	5	150	30/15/0	105	E								5	
MET696	Technologies for processing ferrous and non-ferrous metallurgy slags	3	PD, CCH	4	120	30/0/15	75	E								4	
MET698	Technologies of extraction of rare metals from secondary raw materials	3	PD, CCH	4	120	30/0/15	75	E								4	
M-11. Module of "R&D"																	
MET555	Receive, the quality and certification of by-products in the process of recycling	1	PD, CCH	5	150	30/0/15	105	E								5	
MET635	Fundamentals of scientific research in secondary metallurgy	1	PD, CCH	5	150	30/0/15	105	E								5	
M-12. Module of final attestation																	
ECA103	Final examination		FA	8												8	
Additional type of training (ATT)																	
AAP500	Military training																
Total based on UNIVERSITY:										31	29	28	32	29	31	33	27
										60	60	60	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	0	5	56
BD	Cycle of basic disciplines	0	77	31	108
PD	Cycle of profile disciplines	0	29	39	68
Total for theoretical training:		51	106	75	232
FA	Final attestation				8
TOTAL:					240

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Minutes № 3 dated 20.12.2024

Decision of the Academic Council of the Institute. Minutes № 4 dated 12.12.2024

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Signed:

Governing Board member - Vice-Rector for Academic Affairs

Uskenbayeva R. K.

Approved:

Vice Provost on academic development

Kalpeyeva Z. B.

Head of Department - Department of Educational Program
Management and Academic-Methodological Work

Zhumagaliyeva A. S.

Director - Mining and Metallurgical Institute named after
O.A. Baikonurov

Rysbekov K. .

Department Chair - Metallurgy and mineral processing

Barmenshinova M. .

Representative of the Academic Committee from Employers

Ospanov Y. A.

____ Acknowledged ____

