



**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:	Level 6 - higher education and practical experience
ORC level:	Level 6 - a wide range of special (theoretical and practical) knowledge (including innovative). Independent search, analysis and evaluation of professional information
Training period:	4 years
Volume of loans:	240

Almaty 2023

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

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

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

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

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






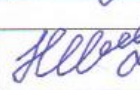
Full name	Academic degree/ academic title	Job title	Place of work	Signature
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Table of contents

List of abbreviations and designations

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

List of abbreviations and symbols

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

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

MNiVO RK - Ministry of Science and Higher Education of the Republic of Kazakhstan;

EP - educational program;

IWS - independent work of a student (student, undergraduate, doctoral student);

IWST - independent work of a student with a teacher (independent work of a student (undergraduate, doctoral student) with a teacher);

WC - working curriculum;

CED - catalog of elective disciplines;

UC - university component;

CC - component of choice;

NQF - National Qualifications Framework;

SQF - Sectoral Qualifications Framework;

LO - learning outcomes;

KC - key competencies.

1. Description of the educational program

It is intended for the implementation of specialized bachelor's degree training in the educational program «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:

- highly qualified continuous training of young scientists and personnel for the university and the economy of the republic according to new methods and specialized Minor programs;

- active involvement of talented students in priority research (fundamental) and scientific and technical (applied) works;

- participation of students in priority scientific works, formation of new knowledge and skills, acquisition of professional experience (work experience) to continue research in 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. 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, possessing professional and personal competencies that allow performing design, production, technological, scientific and technical, organizational and entrepreneurial activities at the facilities of ferrous and non-ferrous metallurgy.

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.

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, 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	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, possessing professional and personal competencies that allow performing design, production and technological, scientific and technical, organizational and entrepreneurial activities at ferrous and non-ferrous metallurgy facilities.
7	EP type	New
8	NQF level	Level 6 - higher education and practical experience
9	ORC level	Level 6 - a wide range of special (theoretical and practical) knowledge (including innovative). Independent search, analysis and evaluation of professional information
10	Distinctive features of the EP	No
11	List of competencies of the educational program:	Professional competencies; Research competencies; Basic competencies and knowledge; Communication competencies; Universal competencies; Cognitive competencies; Creative competencies; Information and communication competencies.
12	Learning outcomes of the educational program:	LO1 - 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. LO2 - to use cognitive-linguistic-cultural methodology in oral and

		<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>LO7 - possess the skills of modeling and creating econometric models of the processes under study; skills of analysis, synthesis, calculation and design of equipment and apparatuses in the planning and management of production in secondary metallurgy.</p> <p>LO8 - To build a personal educational trajectory and improve their knowledge in the field of secondary metallurgy and waste recycling throughout their professional activities.</p>
13	Form of study	full-time
14	Training period	4 years
15	Volume of loans	240
16	Languages of instruction	Kazakh/Russian
17	Awarded Academic Degree	Bachelor of Engineering and Technology
18	Developer(s) and authors:	Barmenshinova M.B. 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	After determining the level (according to the results of diagnostic testing or IELTS results), students are divided into groups and disciplines. The name of the discipline corresponds to the level of English proficiency. When moving from level to level, prerequisites and postrequisites of disciplines are observed.	10	V							
2	Kazakh (Russian) language	The socio-political, socio-cultural spheres of communication and functional styles of the modern Kazakh (Russian) language are considered. The course covers the specifics of the scientific style in order to develop and activate professional communication skills and abilities of students. The course allows students to practically master the basics of the scientific style and develop the ability to produce a structural and semantic analysis of the text.	10	V							
3	Physical Culture	The purpose of the discipline is to master the forms and methods of forming a healthy lifestyle within the framework of the vocational education system. Acquaintance with the natural-scientific foundations of physical education, possession of modern health technologies, the main methods of independent physical education and sports. And also within the framework of the course, the student will master the rules of refereeing in all sports.	8	V							
4	Information and Communication Technologies (in English)	The task of studying the discipline is to acquire theoretical knowledge about information processes, new information technologies, local and global computer networks, methods of information protection; obtaining skills in the use of text editors and spreadsheet processors; creation of databases and various categories of application programs.	5				V				
5	Modern history of Kazakhstan	The course studies historical events, phenomena, facts, processes that took place on the territory of Kazakhstan from ancient times to the present day. The sections of the discipline include: introduction to the history of Kazakhstan; the steppe empire of the Turks; early feudal states on the territory of Kazakhstan; Kazakhstan during the Mongol conquest (XIII century); medieval states in the XIV-XV centuries. The main stages of the formation of Kazakh statehood are also considered: the era of the Kazakh Khanate of the XV-XVIII centuries. Kazakhstan within the Russian Empire; Kazakhstan in the period of civil	5		V						

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

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named after K.I.SATBAYEV»

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

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Cycle of basic disciplines University component											
13	Mathematics I	The course is designed to study the basic concepts of higher mathematics and its applications. The main provisions of the disciplines used in the study of all general engineering and special disciplines taught by graduate departments. The course sections include elements of linear algebra and analytical theory, an introduction to analysis, differential calculus of functions of one and several procedures. The issues, methods of system solutions, the use of vector calculus for solving problems of theory, mechanics, physics are considered. Analytical geometry on the plane and in space, differential calculus of functions of one variable, derivative and differentials, study of behavior functions, gradient derivative and gradient, extremum of a function of several criteria.	5	V							
14	Mathematics II	The discipline is a continuation of Mathematics I. The sections of the course include integral calculus of functions of one variable and several functions, series theory. Indefinite integrals, their properties and methods of their calculation. Definite integrals and their application. Improper integrals. Numerical series theory, series definition theory, control and Maclaurin series, application of series to approximate calculations.	5		V						
15	Physics	The course studies the basic physical phenomena and laws of classical and modern physics; methods of physical research; influence as physics, the science of technology development; the relationship of physics with other sciences and its role in solving scientific and technical problems of the specialty. The course corresponds to the following sections: mechanics, mechanical harmonic waves, fundamentals of molecular kinetic theory and thermodynamics, electrostatics, direct current, electrognatism, geometric optics, wave properties of light, laws of thermal radiation, photoelectric effect.	5	V							
16	Engineering and computer graphics	The discipline is aimed at the study of methods for the image of objects and general rules of drawing, using computer graphics; the study of basic concepts and geometric solutions and methodologies for developing applications with a graphical interface; manages the skills of using graphical systems for the development of drawings, using 2D and 3D modeling methods.	5	V							
17	General chemistry	Objective: has knowledge of fundamental issues of general chemistry and skills of their application in professional activity. Summary of laws, theoretical provisions and conclusions that exclude the basics of disciplinary proceedings; properties and limitations of the environment based on periodic elements of D.I.Mendeleev's law and modern ideas	5		V						

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named after K.I.SATBAYEV»

		about the structure of substances; Fundamentals of thermochemical dynamics and kinetics; processes in solutions; structure of complex compounds.									
18	Physical chemistry	The course Physical Chemistry allows students to form the ability to understand the physico-chemical essence of processes and the basic laws of physical chemistry in complex industrial and technological activities. In the course of training, the student studies the laws of thermodynamics; equations of basic chemical thermodynamics; methods of thermodynamic description and phase equilibria in multicomponent components; properties of solutions; fundamentals of electrochemistry; basic concepts, theories and laws of chemical kinetics and catalysis. The course Physical Chemistry allows students to form the ability to understand the physico-chemical essence of processes and the basic laws of physical chemistry in complex industrial and technological activities. In the course of training, the student studies the laws of thermodynamics; equations of basic chemical thermodynamics; methods of thermodynamic description and phase equilibria in multicomponent components; properties of solutions; fundamentals of electrochemistry; basic concepts, theories and laws of chemical kinetics and catalysis.	5				V				
19	Fundamentals of metal science	Characteristics of secondary raw materials, structural features, forms of finding ferrous, non-ferrous and valuable metals. Modern methods of recycling secondary raw materials. New processes of additional extraction of non-ferrous and valuable metals from secondary raw materials. Selection and justification of methods for processing secondary raw materials, economic analysis and assessment of their possible processing. Waste-free, environmentally friendly technologies for processing secondary raw materials with complex extraction of valuable metals. SWOT analysis of existing and new recycling processes.	5				V				
20	Fundamentals of metal science	Structure of metals, atomic crystal structure and crystal lattices of metals. Real structure of metal crystals, anisotropy of crystal properties. Defects of the 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 the kinetics of phase transformations in metal alloys, the structure of alloys. Diagrams of the state of double and triple metal systems.	5				V				
21	Theoretical foundations of metallurgical processes	Considers laws, theoretical provisions and conclusions on the structure and properties of metallic, oxide and sulfide systems: thermodynamics and kinetics of metallurgical processing of mineral and man-made raw materials, salt melts; liquation and distillation processes of production; methods of refining metals and the main directions of development of the	5					V			

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named after K.I.SATBAYEV»

		theory and practice of extraction and refining of metals, taking into account the integrated use of raw materials and modern environmental requirements.									
22	Production of ferrous and non-ferrous metal alloys from waste	The main melting processes of non-ferrous and ferrous metal alloys include theoretical, technological and constructive issues in the field of traditional and new metallurgy processes. Acquisition of competencies in the analysis of metal production technologies, development of technological schemes and designs of metallurgical units and carrying out technological calculations.	5					V			
23	Design basics and machine parts	Basic requirements for machine parts and assemblies. Criteria for the operability of machine parts and methods of their evaluation. The concept of reliability and its main indicators. Basics of interchangeability. Mechanical transmissions and their classifications. Gears and their classification. Calculation of gear teeth for strength. Worm gears and their classification. Calculation of the strength of worm gears. Belt drives. Chain drives. Shafts and axles. Calculation of shafts for strength. Sliding and rolling bearings. Selection of rolling bearings. Types of connection. Calculation of the strength of the connection.	5					V			
24	Heat transfer and mass transfer in metallurgy	Heat power engineering of the agglomeration process. Heat power engineering of pellet firing. Heat power engineering of the blast furnace process. Heat exchange in a blast furnace. Heat transfer in a layer of lumpy materials. Factors affecting heat exchange processes. Thermal power engineering of converter production. The laws of mass and heat transfer. Mass and heat exchange in the baths of steelmaking units. Thermal balance of oxygen converter melting. Thermal losses of converters. The influence of technological parameters on the thermal operation of converters. Thermal 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			
25	Design of secondary metallurgy enterprises	The design of metallurgical facilities and secondary metallurgy enterprises is a field of knowledge, concepts and ideas about the design of industrial facilities, which is carried out for the purpose of developing and/or drawing up design estimates for the construction of new and/or changes to existing metallurgical facilities during their expansion, modernization, technical re-equipment, reconstruction, restoration, overhaul, conservation and postutilization. The design of metallurgical facilities must be carried out taking into account the provisions of current legislation and state regulations in the field of architectural, urban planning and construction activities.	4					V			
26	Theory and technology of coke-free	In this discipline, the scientific foundations of the processes of coke-free	5						V		

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named after K.I.SATBAYEV»

	metallurgy	metallurgy are considered. Experimental and industrial technologies of metal production in rotary and shaft furnaces, in the fluidized bed and in the melt are described. The issues of production of the final metal from metallized raw materials, as well as the production of reducing gases are considered.										
Cycle of basic disciplines												
Elective component												
27	Theory and technology of preparation of technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical processing	Scrap metal as technogenic raw materials for metallurgical enterprises. Material and energy saving in the recycling of scrap metal. Technologies for the preparation of ferrous and non-ferrous metals used in metallurgical enterprises. The concept of elements - "vagants". Their influence on the quality of ferrous metal products and metallurgical technologies. Circulation of "vagants" in the technological cycle of metallurgical enterprises. Modern standards of the EU, USA and Japan, taking into account the presence of "vagants" in metallurgical raw materials. Preparation of technogenic energy resources. Plastics, solid waste, waste oils and lubricants. Methods of environmentally safe use of technogenic energy resources in metallurgical production.	5			V						
28	Recycling of fine industrial waste	The market of technogenic fine materials. Fine-dispersed solid household and industrial waste. Ash and slag waste. The concept of "shredding" technologies. Shredders. Composition and metallurgical characteristics of "shredding"-dusts. Meal, "heavy" and "light" fractions of shredding dust. Development and prospects of shredding technology. Compacting, briquetting, and caulking of fine technogenic materials. The role of ash and sludge accumulators in the structure of a modern ferrous metallurgy enterprise. Sludge processing technologies: current state and prospects. Agglomeration and production of pellets using man-made and recycled materials.	5			V						
29	Wastewater treatment processes and devices	Properties and classification of waters according to their intended purpose. Issues of environmental safety of the hydrosphere. Fundamentals of water use in circulating and closed water supply systems of enterprises, as well as mechanical, chemical, physico-chemical, biochemical and thermal methods for removing soluble and insoluble contaminants from industrial wastewater. The main designs of devices, installations and structures for wastewater treatment from suspended and dissolved impurities. Constructive calculation of devices used in wastewater treatment: settling tanks, filters, flotators, adsorbers, electrolyzers, extractors, rectification plants, aerotanks and biofilters	5				V					
30	Physico-chemical methods of analysis	The main types of physico-chemical methods of analysis: spectral, electrochemical, chromatographic. The theoretical principles of the methods, the device and principles of operation of analytical equipment,	5				V					

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		methods of computer processing of experimental results are described.										
31	Continuous casting of steel	The importance of casting tasks for obtaining high-quality metal. Factors affecting the technical and economic indicators of production and quality of steel and electric fireplaces. A brief description of the main casting methods. The main physico-chemical, thermal and hydrodynamic problems of the studied discipline are considered. The concept of crystallization and solidification. Theory of casting of metals and alloys. Technologies of casting metals and alloys.	5					V				
32	Recycling technologies in the metallurgy of rare metals	Characteristics of waste containing rare metals. Recycling of waste of molybdenum, tungsten and niobium alloys using oxidative methods, electrochemical methods and halogenation methods. Extraction of rhenium from fine and lumpy waste of heat-resistant nickel alloys (ZHNS). Recycling of scrap of electronic equipment containing rare metals using pyro-, hydrometallurgical technologies. Recycling of waste of tungsten steels and hard alloys with the processing of lump waste (scale, chips, edge trimming after rolling, unused parts of tool plates, their fragments, defective products, etc.) and pulverized abrasive materials (dust from sharpening carbide tools). Extraction of indium from secondary raw materials by the amalgam method. Recycling of gallium-containing waste of radioelectronics and electronics, processing of gallium arsenide waste by thermal dissociation, fusing with alkali in the presence of an oxidizer, chlorination followed by rectification. Recycling of deactivated molybdenum-nickel, platinum-rhenium catalysts. Extraction of rhenium, molybdenum and tungsten from various solutions of hydrometallurgical processing of ore, technogenic and secondary raw materials. Extraction of germanium from dust formed during the processing of copper and zinc concentrates, from the dust of gas plants.	5					V				
33	Ecology of the metropolis	Assessment of the state of the environment under global changes; the main stages of the development of civilization and environmental crises characteristic of each of them; principles of respect for nature and sustainable development of civilization; methods of conducting field and laboratory environmental studies. Analysis of environmental processes and phenomena; formation of an ecological worldview based on the use of the provisions of the concept of sustainable development	5						V			
34	Theory and technology of steelmaking processes	Steel production is the second stage of a two-stage scheme for extracting iron from ores by converting cast iron and metal waste into steel. The essence of steelmaking processes consists in the oxidation of impurities of cast iron and steel scrap (carbon, silicon, manganese, phosphorus and others) with iron oxides of slag, iron ore, pure oxygen or air oxygen and bringing the composition of the liquid metal to the composition of grade steel, followed by its deoxidation and alloying.	5						V			

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

35	Dust collection and condensation in metallurgy	The course "Dust collection and condensation in metallurgy" aims to acquire students' knowledge and skills of working with equipment for dust collection and condensation in metallurgy. Students should know the theoretical and technological patterns of dust removal of particles processed during pyrometallurgical processes of materials depending on humidity, temperature, gas flow, size, as well as technological parameters during condensation of metal vapors and their compounds.	5							V		
36	Special electrometallurgy	Basic laws of theoretical and applied electrochemistry. Technological bases of electrofining and electrodeposition of non-ferrous metals in aqueous and molten media, electroplating the surface of products, as well as obtaining metal powders under electrolysis conditions.	5							V		
37	Recycling of waste and secondary raw materials of precious metals	Classification and characteristics of secondary and man-made raw materials, categories of precious metals. The main methods of processing silver-, gold-, platinum-containing raw materials. Pyro- and hydrometallurgical methods for obtaining secondary refined metals and intermediates for processing enterprises.	6								V	
38	Technology of foundry production	A brief overview of the history of the technology of forming castings. The structure of the production of castings and the use of various technologies. The sequence of manufacturing a single casting mold. Schemes of technological processes for obtaining castings. Basic concepts and terms. The structure of the production of castings using various technologies. General technological schemes for the manufacture of castings. Types of foundry production.	6								V	
Cycle of profile disciplines University component												
39	Metals and their compounds	The discipline studies the physical and chemical properties of metals, their compounds and alloys, their ores, deposits, distribution in nature. The main methods of production, as well as the use of metals, their compounds and alloys in science and technology.	4	V								
40	General metallurgy	Production of cast iron and iron: raw materials and their preparation; the design of the blast furnace; the blast furnace process; equipment and operation of the sites servicing the blast furnace; the performance of blast furnaces; methods of non-domain (coke-free) iron production. Steel production: general fundamentals of steelmaking; converter steel production; open-hearth steel production; steel smelting in electric furnaces; ingots and casting of steel; continuous casting of steel; modern technologies for obtaining high-quality steel; non-furnace steel processing; complex technologies of non-furnace processing of cast iron and steel; production of steel in continuous units; remelting processes. Production of non-ferrous metals: metallurgy of copper; metallurgy of nickel; metallurgy of aluminum; production of other non-ferrous metals.	6			V						

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named after K.I.SATBAYEV»

41	Technology of metallurgical processes	Obtaining knowledge about the structure and properties of metallic, oxide and sulfide systems; about the basic laws of thermodynamics, mechanism and kinetics of the main metallurgical processes - liquation, distillation, redox processes, processes of processing of sulfide raw materials; exchange and oxidative leaching of compounds of various compositions, separation of metals from solutions by precipitation of insoluble compounds, cementation, sorption, on the main directions of development of the theory and practice of extraction and refining of metals, taking into account the integrated use of raw materials and modern environmental requirements; skills in performing calculations on thermodynamics and kinetics of metallurgical processes.	5							V	
42	Econometric modeling of metal recycling	This course is a generalization of students' knowledge in special disciplines, as well as an economic and mathematical description of technological processes for conducting experiments and studying them on a model. The concept of models and modeling, systems and their characteristics. Theories and similarity criteria for process modeling. Identification methods. Methods of developing information databases. Visualization and animation of models.	5							V	
43	Modern ecological schemes and forecasting in metallurgy	The impact of metallurgy on the environment. The main factors of environmental impact. Resource consumption. General principles of creating environmentally friendly metallurgy. The main requirements for environmentally friendly production of steel. Creation of environmentally friendly metallurgy. Comparative description of various methods of metallurgical production.	6							V	
44	Equipment of metallurgical workshops	Machines and aggregates for the preparation of charge materials for blast furnace melting. Bowl pelletizers of the charge. Blast furnace shop. Skip winches. Machines and aggregates of steelmaking production. Machines and units of oxygen converter shops. Melting furnaces. Horizontal converters. Scrubbers. Equipment for casting metals. Carousel filling machines. Carousel filling machines for zinc casting. Equipment for fire refining of copper.	4							V	
Cycle of profile disciplines Component of choice											
45	Technology of waste disposal and disposal in industry	The main environmental problems of production and consumption of ferrous and non-ferrous metals. Hazard classes of toxic waste in metallurgy. Characteristics and classification of industrial waste. The main methods of recycling, neutralization and disposal of waste in industry. Disposal and neutralization of gases containing fluorine, chlorine, mercury, sulfur compounds and other harmful substances. Storage and disposal of industrial waste. Processing and disposal of industrial waste using full factory technology.	5							V	

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

46	Fundamentals of metallurgical production design	General principles of investment and integrated technological design, characteristics of modern metallurgical workshops, production facilities, enterprises as objects designed in their classical, probabilistic, statistical and cenological visions, methods of project development at the initial pre-project, design and post-project stages, characteristics and principles of components of all major technological conversions in ferrous and non-ferrous metallurgy.	5						V		
47	Logistics of waste management	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. The use of production and consumption waste as secondary resources in the production of ferrous and non-ferrous metals. Heat treatment of waste. Waste disposal at landfills.	4						V		
48	Modeling of metallurgical processes	The concept of models and modeling, systems and their characteristics. Theories and similarity criteria for process modeling. Identification methods. Methods of developing information databases. Visualization and animation of models.	4						V		
49	Recycling technologies in foundry production	Technogenic foundry raw materials: steel and cast iron scrap of complex composition. Metallurgical dust and briquettes. Metalworking waste: chips, trimmings, scale, including oil-containing. Melting in a cupola with the injection of metal-containing fine materials. Capture of sublimations 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 melting technology in a cupola for processing man-made and secondary raw materials.	6							V	
50	Recycling technologies in steel production	Movement of secondary metallurgical materials at a full-cycle enterprise. Trim, scale. Welding slag of rolling shops. Steel and cast iron scrap. Recycling in steelmaking units of scrap metal from parts with coatings, including organic materials. Steelmaking slags, slurries and dusts: micro-mixed composition, methods of safe storage and storage, processing in converters and hearth steelmaking units. The influence of scrap metal quality on the technology of steel smelting in open-hearth furnaces, oxygen converters and electric arc furnaces. Features of the use of technogenic raw materials in mini steelmaking plants. Requirements for charge materials and waste. Special technologies and aggregates for the processing of scrap metal and metallurgical dusts.	6							V	
51	Processes and devices for processing waste and secondary raw materials	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	5							V	

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

		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.									
52	Digitalization of secondary metallurgy enterprises	The theory of building digital systems for various levels of production management at secondary metallurgy enterprises. Analysis of the structure, functional and supporting parts of digitalization, methodological foundations of building digital technologies. The role of digital technologies in improving the economic management mechanism at secondary metallurgy enterprises, as well as the construction of their information support. The use of digital technologies to optimize processes in order to reduce the risk of injury to people working in hazardous areas. Technological process management and maintenance of secondary metallurgy enterprises through the use of intelligent analytical software packages and control in an integrated way.	5							V	
53	Recycling of metallurgical waste	Features of waste disposal of the fuel industry and energy. Composition and metallurgical properties of coal enrichment and oil refining waste, energy ash and slag. Compaction, transportation, storage and preparation for metallurgical processing. Modern processing technologies, including metallurgical ones, their advantages and disadvantages. Disposal of transport waste. Special requirements of advanced industrial countries for the recycling of transport waste. Waste 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 waste in the agglomeration process. Special metallurgical technologies, PYROXEL process. Disposal of waste of the first hazard class. Modern requirements for recycling and classification of toxic waste.	5								V
54	Consumer properties of metallurgical products	Classification of steel products. General requirements for the consumer properties of steel products. The system of standardization and certification of metallurgical products. Metallurgical products of the mining and processing complex, mining and pig industry, nuclear industry and customer requirements for its properties.	5								V
55	Recycling technologies in metallurgy of heavy non-ferrous metals	Secondary raw materials of heavy non-ferrous metals. Preparation of secondary raw materials of heavy non-ferrous metals for metallurgical processing. Fundamentals and methods of pyro- and hydrometallurgical	5								V

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named after K.I.SATBAYEV»

		processing of secondary raw materials of heavy non-ferrous metals. Hardware design for the production of secondary heavy non-ferrous metals. Technology of recycling of waste and secondary raw materials of lead, copper, zinc, nickel. Auxiliary processes in the production of secondary heavy non-ferrous metals. Environmental and economic aspects of the production of secondary heavy non-ferrous metals.									
56	Recycling technologies in light metal metallurgy	Sources of raw materials and characteristics of commercial products of secondary aluminum, titanium and magnesium enterprises. The processes of primary and metallurgical processing of scrap, aluminum, titanium and magnesium waste and the equipment used in this process. Fundamentals of designing technological schemes of workshops and factories for the production of secondary light metals, issues of economics, ecology, waste disposal and labor protection.	5								V
57	Technologies for processing ferrous and non-ferrous metallurgy slags	Characteristics of slags and their properties. Methods of processing blast furnace slags. Processing of steelmaking and ferroalloy slags. Technologies for processing non-ferrous metallurgy slags. The use of slags in metallurgy. The use of slags in the construction industry.	4								V
58	Technologies of extraction of rare metals from secondary raw materials	Technologies for the extraction of zirconium, hafnium, tungsten, tantalum and niobium from various types of secondary applications: metal waste, refractory blocks, waste and blocks of monolithic alloys, shock-absorbing blocks of capacitors. The role of man-made and secondary resources in the production of electromagnetic radiation. Technologies for the extraction of rhenium, germanium, gallium from secondary and man-made raw materials.	4								V
59	Receipt, quality and certification of associated products during recycling	Features of metallurgical processes during melting "for slag". Blast furnace melting using man-made materials and obtaining slag of a given composition. Regularities of mass exchange between metal and slag. Formation of neutral compositions of elements - "vagants". 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
60	Fundamentals of scientific research in secondary metallurgy	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.	5								V

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		Preparation of scientific documentation, presentation of research results. Efficiency and implementation of scientific developments. Directions of research in secondary metallurgy.									
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5 Curriculum of the educational program



KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY named after K. SATBAYEV



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

Educational program 6B07212 - "Recycling in metallurgy"
Group of educational programs B071 - "Mining and extraction of minerals"

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

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

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

CHE495	Chemistry	BD, UC	5	150	1/1/1	105	E		5						
CHE127	Physical chemistry	BD, UC	5	150	1/1/1	105	E				5				
MET515	Theory and technology of preparation of technogenic and secondary raw materials of ferrous and non-ferrous metallurgy for metallurgical processing	BD, CCH	5	150	2/1/0	105	E		5						
MET520	Recycling of fine industrial waste				2/0/1										
MET631	Wastewater treatment processes and devices	BD, CCH	5	150	2/1/0	105	E		5						
CHE593	Physical and chemical methods of the analysis				2/1/0										
MET408	Continuous casting of steel	BD, CCH	5	150	2/1/0	105	E				5				
MET634	Recycling technologies in the metallurgy of rare metals				2/0/1										
MET651	Ecology of the metropolis	BD, CCH	5	150	2/0/1	105	E					5			
MET513	Theory and technology of steelmaking processes				2/0/1										
MET143	Dedusting facilities and condensation in metallurgy	BD, CCH	5	150	2/0/1	105	E					5			
MET518	Special electrometallurgy				2/0/1										
MET695	Recycling of waste and secondary raw materials of precious metals	BD, CCH	6	180	2/0/2	120	E							6	
MET147	Metallurgical furnaces				2/0/2										
AAP179	Educational practice	BD, UC	2		0/0/2				2						
M-8. Basic training module on metal recycling															
MET627	Fundamentals of the specialty in secondary metallurgy	BD, UC	5	150	2/0/1	105	E			5					
MET628	Fundamentals of metal science	BD, UC	5	150	2/0/1	105	E				5				
MET639	Theoretical foundations of metallurgical processes	BD, UC	5	150	2/0/1	105	E					5			
MET629	Production of ferrous and non-ferrous metal alloys from waste	BD, UC	5	150	2/1/0	105	E					5			
GEN125	Bases of designing and details of cars	BD, UC	5	150	1/1/1	105	E					5			
MET640	Heat transfer and mass transfer in metallurgy	BD, UC	5	150	2/1/0	105	E					5			
MET633	Design of secondary metallurgy enterprises	BD, UC	4	120	2/0/1	75	E					4			
MET566	Theory and technology of non-coke metallurgy	BD, UC	5	150	2/0/1	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	2/0/1	75	E	4							
MET454	General metallurgy	PD, UC	6	180	2/0/2	120	E			6					
MET123	Technology of metallurgical processes	PD, UC	5	150	2/0/1	105	E							5	
MET632	Econometric modeling of metal recycling	PD, UC	5	150	2/1/0	105	E							5	
MET498	Modern ecological schemes and forecasting in metallurgy	PD, UC	6	180	2/0/2	120	E							6	
TEC481	Equipment of metallurgical shops	PD, UC	4	120	2/0/1	75	E						4		

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

M-10. Professional activity module															
MET638	Technology of waste disposal and disposal in industry	PD, CCH	5	150	2/0/1	105	E					5			
MET575	Fundamentals of metallurgical production design				2/0/1										
MET136	Modelling of metallurgical processes	PD, CCH	4	120	2/0/1	75	E					4			
MET650	Logistics of waste management				2/0/1										
MET540	Recycling technologies in foundry production	PD, CCH	6	180	2/1/1	120	E					6			
MET535	Recycling technologies in the production of steel				2/1/1										
MET636	Processes and devices for processing waste and secondary raw materials	PD, CCH	5	150	2/0/1	105	E					5			
MET637	Digitalization of secondary metallurgy enterprises				2/0/1										
MET525	Recycling of waste from metallurgical industries	PD, CCH	5	150	2/0/1	105	E						5		
MET590	Consumer properties of metallurgical products				2/0/1										
MET545	Recycling technologies in heavy non-ferrous metals metallurgy	PD, CCH	5	150	2/0/1	105	E						5		
MET550	Recycling technologies in light metal metallurgy				2/1/0										
MET696	Technologies for processing ferrous and non-ferrous metallurgy slags	PD, CCH	4	120	2/0/1	75	E						4		
MET698	Technologies of extraction of rare metals from secondary raw materials				2/0/1										
AAP143	Production practice I	PD, UC	2		0/0/2					2					
AAP183	Production practice II	PD, UC	3		0/0/3							3			
M-11. Module of "R&D"															
MET555	Receive, the quality and certification of by-products in the process of recycling	PD, CCH	5	150	2/0/1	105	E						5		
MET635	Fundamentals of scientific research in secondary metallurgy				2/0/1										
M-12. Module of final attestation															
ECA108	Final examination	FA	8										8		
M-13. Module of additional types of training															
AAP500	Military affairs	ATT	0												
Total based on UNIVERSITY:								31	29	28	32	29	31	33	27
								60		60		60		60	

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
		required component (RC)	university component	component of choice (CCH)	Total
GED	Cycle of general education disciplines	51		5	56
BD	Cycle of basic disciplines		71	31	176
PD	Cycle of profile disciplines		35	39	
	Total for theoretical training:	51	106	75	232
FA	Final attestation	8			8
	TOTAL:	59	106	75	240

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

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

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

Vice-Rector for Academic Affairs

B.A. Zhautikov

Director of the Mining and Metallurgical Institute named after
O. A. Baikonurov

K.B. Rysbekov

Head of department "Metallurgy and mineral processing"

M.B. Barmenshinova

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

E.A. Ospanov

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

R.R. Protsenko

Representative of the employers' council of the Weizmann RI

V.A. Kaplan

6. Additional educational programs (Minor)

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