



**SATBAYEV
UNIVERSITY**

**Institute Mining and Metallurgical
Department of Metallurgical processes, Heat engineering and Technologies of special
materials**

DOUBLE DIPLOMA DEGREE PROGRAM

7M07229 – «Extractive metallurgy»

Code and classification of the field of education:	7M07 – Engineering, manufacturing and construction industries
Code and classification of training directions:	7M072 – Manufacturing and processing industries
Group of educational programs:	M117 – «Metallurgical Engineering»
Level based on NQF:	7
Level based on IQF:	7
Study period:	2 years
Amount of credits:	120

Almaty 2025

Double diploma educational program «7M07229 – Extractive Metallurgy» was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Protocol № 4 dated « 12 » 12 2024 y.

was reviewed and recommended for approval at the meeting of K.I. Satbayev KazNRTU Educational and Methodological Council

Protocol № 3 dated « 20 » 12 2024 y.

Educational program «7M07229 – Extractive Metallurgy» was developed by Academic committee based on direction «7M072 – Manufacturing and processing industries»

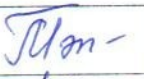
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Chairperson of Academic Committee:				
Barmenshinova M.B.	c.t.s., associate professor	Head of the department of Metallurgy and Mineral Processing	K.I.Satbayev KazNRTU	
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List of abbreviations and designations

NCJS «Kazakh National Research Technical University named after K.I. Satpayev» – NCJS KazNITU named after K.I. Satpayev;

TSCSE – The State compulsory standard of education of the Republic of Kazakhstan;

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

EP – educational program;

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

IWSWT – 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;

IQF – Industry qualifications framework;

LO – learning outcomes;

KC – key competencies;

SDG – Sustainable Development Goals.

1. Description of educational program

The educational program 7M07229 – «Extractive metallurgy» includes sectoral, priority, fundamental, natural science, general engineering and professional training of masters in the field of extractive metallurgy, aimed at modern, complex, resource-saving, lean and sparing processing of raw materials and production of products with increased added value, to obtain energy-generating metals, in accordance with atlas of new professions, production requests and trends in the global metals market.

It is intended for the implementation of specialized bachelor's degree training under the educational program 7M07229 – «Extractive Metallurgy» at Satbayev University and was developed within the framework of the direction "Manufacturing and processing industries".

A distinctive feature of the 7M07229 - Extractive Metallurgy program is that the educational program provides international, practice-oriented training of undergraduates capable of independent research and innovation and project activities, the program is a double diploma degree program jointly with NUST MISIS (Moscow, Russia). The concept of the educational program differs in that the training is aimed at the formation of competencies for obtaining energy-generating metals; transformation of existing technologies in the field of non-ferrous metallurgy to the principles of gentle, environmentally friendly, complex processing of raw materials in conditions of depletion of ores and waste, while simultaneously digitalizing production.

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 amendments 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 education 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 27.12.2019 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 qualification 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 involves the training of specialists in the field of metallurgy, corresponding to the atlas of new professions and trends in the development of the metallurgical sector, namely in the following areas: adaptation of technological schemes to depletion of ores, greening of metallurgical industries, efficient recycling of waste from the metallurgical sector, increased automation and robotization of production, increasing the degree of wear of equipment in the mining and metallurgical sector.

The educational program is aimed at the formation of competencies in the field of new metallurgical technologies and promising areas of development of technologies for processing raw materials of heavy and light metals, rare and noble, refractory, energy-generating metals, as well as the study of methodological principles of lean R& D and the practice of their use to measure the level of readiness of an innovative product /project for commercialization.

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 metallurgical industry:

Types of labor activity. Specialists who have graduated from the master's degree program perform production, technological and organizational work at

industrial enterprises in leading positions corresponding to the 7th level of the national qualification framework, as well as conduct research work in the field of complex processing of mineral raw materials and obtaining innovative products of increased consumer properties.

Types of economic activity: processing of ores of heavy, light, rare, refractory non-ferrous metals, uranium ores; production of energy-generating metals; processing of technogenic metallurgical raw materials; disposal of waste from metallurgical industries.

Objects of professional activity. The objects of professional activity of graduates are the existing metallurgical enterprises of ferrous and non-ferrous metallurgy, extractive metallurgy technologies aimed at transforming production on the principle of lean production, greening, obtaining energy-generating metals, as well as processing plants, chemical, mining, chemical and machine-building industries, industry research and design institutes, factory laboratories that carry out similar activity.

2. Purpose and objectives of educational program

Purpose of EP: formation of personnel for "Society and Economy 5.0" based on "Industry 4.0" in the field of metallurgy, training in the transformation of technologies to the conditions of depletion of ores, increasing the volume of processed raw materials for critically important non-ferrous metals; training in the transformation of technologies for processing waste of the metallurgical industry, in which they return to economic circulation in the form of renewable fuels, secondary raw materials or marketable products, transformation of the ideology of sparing production, resource conservation at industry enterprises, reduction of the "Carbon footprint" of technologies; formation of competencies for obtaining energy-generating metals; training in the transformation of automation technologies and robotization of metallurgical production.

Tasks of EP:

1. Formation of theoretical knowledge and practical skills in the field of extractive gentle metallurgy, greening of existing technologies of metallurgical production, complex processing of raw materials and waste containing metals.
2. Formation of theoretical knowledge and practical skills in the field of resource-saving, lean and sparing processing of raw materials, production of products with increased added value.
3. Formation of theoretical knowledge and practical skills in the field of renovation of the existing technological process in the process of energy intensity, resource conservation, complexity of extraction of critical metals for the country's economy and the choice of an appropriate technological scheme.
4. Formation of competencies in the field of consumer properties of products made of energy-generating metals, innovative technologies for their production.
5. Formation of competencies in the field of scientific and technical, organizational and methodological activities and promising areas of technology development focused on the production of refractory and precious metals, rare earth and

radioactive rare metals and their compounds from various types of natural and man-made raw materials.

6. Formation of competencies in the field of lean R&D development and subsequent commercialization of the project.

7. Competence of graduates in the system of digitalization of metallurgical processes. Acquisition of competencies in production management at all stages of the life cycle of manufactured products.

The Master of Technical Sciences in the field of extractive metallurgy must solve the following tasks in accordance with the types of professional activity:

research activities:

- the ability to form diagnostic solutions to professional problems by integrating the fundamental sections of sciences and interdisciplinary knowledge gained during the development of the master's degree program;

- the ability to independently conduct scientific experiments and research in the professional field, generalize and analyze experimental information, draw conclusions, formulate conclusions and recommendations, make a choice of technological schemes that contribute to the greening and resource conservation of production;

- the ability to create and explore models of the studied objects based on the use of in-depth theoretical and practical knowledge in the field of extractive metallurgy and interdisciplinary approaches to knowledge generation;

scientific and production activities:

- the ability to independently carry out production and scientific-production, laboratory and interpretation work in solving technological problems;

- the ability to professionally operate modern laboratory and technological equipment in the field of extractive metallurgy;

- the ability to use modern methods of processing and interpreting complex information to solve production problems;

project activities:

- the ability to independently draw up and submit projects of research and scientific-production works;

- readiness to design complex research and scientific-production works with the transformation of existing technologies to the principles of lean manufacturing and gentle metallurgy;

organizational and managerial activities:

- readiness to use practical skills of organization and management of research and scientific-production works in solving professional tasks;

- readiness for the practical use of regulatory documents in the planning and organization of scientific and production work;

scientific and pedagogical activity:

- ability to conduct seminars, laboratory and practical classes;

- the ability to participate in the management of scientific and educational work of students in the field of extractive metallurgy.

3. Requirements for evaluating the educational program learning outcomes

A graduate of a scientific and pedagogical master's program must:

have an idea:

- about the role of science and education in public life;
- about modern trends in the development of scientific knowledge;
- about current methodological and philosophical problems of natural sciences;
- about the professional competence of a higher school teacher;
- about communicative, professional and technical language knowledge, about philosophical concepts of natural science, scientific worldview.
- about the patterns of management activities, systemic and ecological thinking, critical thinking, leadership, teamwork and communication.
- about teaching skills and mentoring undergraduate students.
- about design, research, inventive, innovative activities in the field of processing of mineral raw materials and metallurgy;
- on the principles of automation and digitalization of metallurgical processes.

know:

- methodology of scientific knowledge;
- principles and structure of the organization of scientific activity;
- psychology of cognitive activity of students in the learning process;
- psychological methods and means of increasing the effectiveness and quality of training;
- international and domestic standards, regulations, instructions, orders of higher and other domestic organizations, methodological normative and guidance materials relating to the work performed;
- current state and prospects for technical and technological development of enrichment and metallurgical processes, features of the activities of institutions, organizations, enterprises and related industries;
- goals and objectives facing a specialist in the field of extractive and gentle metallurgy;
- modern methods of studying enrichment and metallurgical processes, equipment operation;
- basic requirements for technical documentation, materials and products;
- rules and regulations of labor protection, issues of environmental safety of technological processes;
- methods of conducting expert assessment in the field of life safety and environmental protection;
- standards in the field of quality management;
- achievements of science and technology, advanced domestic and foreign experience in the field of mineral processing and metallurgy;
- at least one foreign language at a professional level, allowing for scientific research and practical activities;

- methodology for conducting all types of training sessions and independent work of students.

be able to:

- demonstrate communicative, professional and technical language knowledge in a foreign, professional language.
- integrate psychological patterns of management activities;
- demonstrate skills in teaching and mentoring undergraduate students;
- explore empirical data based on scientific research methodology for the ability to write articles, collect scientometric data, to protect intellectual property using the principles of project management;
- apply and implement fundamentally new schemes for obtaining metals, based on saving resources and preserving the environment, in conditions of depletion of ores, reducing the concentration of metals in ores;
- solve engineering calculations in the field of extractive metallurgy, thermodynamics and kinetics of pyro- and hydrometallurgical processes; justify the choice of processes and requirements for rectification and condensation processes;
- develop and research modern technologies for producing energy-generating, radioactive, refractory metals; carry out calculations and selection of main and auxiliary equipment for hydro-, pyro- and electrometallurgical processes in non-ferrous metallurgy, calculate and predict electro- and metallothermic production of metals and alloys;
- transform existing technologies to the principles of lean production and gentle metallurgy;
- differentiate the modern physical and chemical complex of methods for analyzing metallurgical raw materials and products, design powder materials;
- apply modern, advanced knowledge about innovative technologies for obtaining rare, rare-earth and noble metals, light and refractory metals, using resource- and energy-saving techniques for technological schemes;
- rationalize the use of critical, strategic and man-made raw materials, manage waste from metallurgical production;
- prevent and predict problems of corrosion of structures in the metallurgical industry; demonstrate awareness of the various types and types of equipment in the field of metallurgy in order to select the most optimal layout schemes and prevent structural problems;
- program, develop “MES systems” for collecting and storing data from technological processes of metallurgy.
- systematize the principles of constructing digital data processing tools, using microprocessors in control systems for technical objects and technological processes, design control systems based on microcontrollers, and develop application software.
- analyze the consumer properties of products made from energy-generating metals and apply statistical methods of quality management at production enterprises in the metallurgical industry.

have the skills:

- research activities, solving standard scientific problems;
- implementation of educational and pedagogical activities on credit technology of education;
- methods of teaching professional disciplines;
- use of modern information technologies in the educational process;
- professional communication and intercultural communication;
- oratory, correct and logical presentation of one's thoughts in oral and written form;
- expanding and deepening the knowledge necessary for everyday professional activities and continuing education in doctoral studies.
- forming a search for economically feasible technologies and methods for reducing the emission of harmful substances into the environment;
- identification and assessment of environmental risks when conducting economic activities in metallurgical production;
- monitoring the environmental situation at deposits, enrichment and processing plants;
- determining the impact of technological processes on the ecosystem;
- application of techniques to reduce gaseous emissions from metallurgical enterprises, selection of equipment;
- gentle metallurgy when creating environmentally friendly production, methods for reducing emissions and waste from metallurgy.

be competent:

- in research and innovation-project activities;
- in technologies for producing energy-generating metals;
- in the transformation of existing technologies in the field of non-ferrous metallurgy to the principles of gentle, environmentally friendly, comprehensive processing of raw materials in conditions of depletion of ores and waste, while simultaneously digitalizing production;
- in adapting technological schemes to ore depletion;
- in the greening of metallurgical production, effective recycling of waste from the metallurgical sector;
- in increasing automation and robotization of production, increasing the degree of wear and tear of equipment in the mining and metallurgical sector;
- in matters of modern educational technologies;
- in carrying out scientific projects and research in the professional field;
- in ways to ensure constant updating of knowledge, expansion of professional skills and abilities.

B - basic knowledge, skills and abilities

B1 - Know the history and philosophy of science, pedagogy and psychology of management, pedagogy of higher education;

B2 - The ability to independently apply methods and means of cognition, training and self-control to acquire new knowledge and skills, including in new areas not directly related to the field of activity;

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

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

B5 - Knowledge of professional terminology and the ability to work with educational and scientific materials in the specialty in the original in a foreign language. Proficiency in communication and professional terminology;

B6 - General engineering skills, engineering calculations in metallurgy;

B7 - Possession of fundamental knowledge on the theory of mineral processing and metallurgical processes;

B8 - Basic knowledge of waste management, metal recycling;

B9 - Planning experiments and processing experimental data;

B10 - Know and master the main business processes at an industrial enterprise, implement the principles of gentle metallurgy and greening processes

P - professional competencies,

P1 – Able to evaluate the results of scientific and technical developments, scientific research and justify one's own choice, systematizing and summarizing achievements in the metallurgy industry and related fields;

P2 - Fundamental problems of non-ferrous metallurgy. Apply the basic principles of lean R&D and their use to measure the level of readiness of an innovative product/project for commercialization;

P3 - Able to develop proposals to improve the efficiency of use of raw materials and energy resources in the production of non-ferrous, rare and precious metals;

P4 - Theoretical and technological foundations of processes and technologies for the production of non-ferrous metals and their compounds;

P5 - Able to find and process information required for decision-making in scientific research and practical technical activities, carry out modeling, analysis and experiments in order to conduct detailed research to solve complex problems in the professional field;

P6 - Possess the skills to carry out technological, thermal and energy calculations;

P7 - Databases, application packages and computer graphics tools for solving professional problems;

P8 - Be able to calculate and select main and auxiliary equipment;

P9 - Able to implement resource management;

P10 - Able to apply professional knowledge to create flexible, multi-purpose and/or energy-saving advanced metallurgical processes and technologies for processing primary and/or secondary raw materials of non-ferrous, rare and precious metals;

P11 - Theoretical and technological foundations of progressive technologies and the latest methods of intensifying metallurgical processes for the production of non-ferrous metals;

P12 - Able to conduct research and development work on the subject of the organization;

P13 - Be able to develop energy- and resource-saving technologies in the field of extractive metallurgy;

P14 - Be able to perform calculations of processes and apparatus of extractive metallurgy;

P15 - Apply the principles of gentle metallurgy;

P16 - Able to develop scientific, technical, design and service documentation, prepare scientific and technical reports, surveys, publications, reviews, design and develop products, processes and systems under conditions of uncertainty and alternative solutions in interdisciplinary fields;

P17 - Able to solve production and (or) research problems based on fundamental knowledge, knowledge in interdisciplinary fields in the field of metallurgy;

P18 - Able to evaluate the results of scientific and technical developments, scientific research and justify one's own choice, systematizing and summarizing achievements in the metallurgy industry and related fields;

P19 - Apply the basic principles of lean R&D and the practice of their use to measure the level of readiness of an innovative product/project for commercialization;

P20 - Apply intellectual property and patent protection skills

P21 - Apply gentle and lean metallurgy techniques in the metallurgy of rare earth and radioactive metals, in the production of rare earth and radioactive metals

O - universal, social and management competencies

O1- Able to fluently use English as a means of business communication, a source of new knowledge in the field of automation or robotization of production processes. Ready to use English in professional activities in the field of enrichment and metallurgy;

O2- Is able to speak fluently the Kazakh (Russian) language as a means of business communication, a source of new knowledge in the field of automation or robotization of production processes. Ready to use the Kazakh (Russian) language in professional activities in the field of enrichment and metallurgy;

O3 - Know and apply in work and life the basics of applied ethics and ethics of business communication;

O4- Know and apply the basic concepts of professional ethics;

O5- Know and solve problems of human influence on the environment.

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 problems, argumentation of conclusions and competent handling of information;

C2 - Be a specialist in conducting experimental studies of extractive metallurgy and recycling objects;
protection at work and the ability to use them in practice.

C3 - To be a researcher, a specialist in scientific research of ore processing facilities, extractive metallurgy and recycling;

C4 - Be an engineer for the development and design of metallurgical production lines.

C5- Be able to find and process information required for decision-making in scientific research and practical technical activities, carry out modeling, analysis and experiments in order to conduct detailed research to solve complex problems in the professional field.

4. Passport of educational program

4.1. General information

№	Field name	Comments
1	Code and classification of the field of education	7M07 - Engineering, manufacturing and construction industries
2	Code and classification of training directions	7M072 - Manufacturing and processing industries
3	Educational program group	M117 – Metallurgical Engineering
4	Educational program name	7M07229 - Extractive Metallurgy
5	Short description of educational program	The educational program "Extractive Metallurgy" includes industry-specific, priority, fundamental, natural science, general engineering, practice-oriented and professional training of masters in the field of extractive metallurgy, aimed at modern, complex, resource-saving, lean and sparing processing of raw materials and production of products with increased added value, to obtain energy-generating metals in accordance with with an atlas of new professions, production requests and trends in the global metals market.
6	Purpose of EP	Formation of personnel for "Society and Economy 5.0" based on "Industry 4.0" in the field of metallurgy, training in the transformation of technologies to the conditions of depletion of ores, increasing the volume of processed raw materials for critically important non-ferrous metals; training in the transformation of technologies for processing waste of the metallurgical industry, in which they return to economic circulation in the form of renewable fuels, secondary raw materials or marketable products, transformation of the ideology of sparing production, resource conservation at industry enterprises, reduction of the "Carbon footprint" of technologies; formation of competencies for obtaining energy-generating metals; training in the transformation of automation technologies and robotization of metallurgical production.
7	Type of EP	Innovative
8	The level based on NQF	7
9	The level based on IQF	7
10	Distinctive features of EP	A double diploma degree
11	List of competencies of educational program	1) <i>have an idea:</i> - about the role of science and education in public life;

		- about modern trends in the development of scientific knowledge; - about the professional competence of a higher school teacher. 2) <i>know</i>: – methodology of scientific knowledge; – principles and structure of organizing scientific activity; – goals and objectives facing a specialist in the field of mineral processing and metallurgy for the development and implementation of the latest high-tech production technologies; – methods for studying enrichment and metallurgical processes, equipment operation. 3) <i>be able to</i>: – develop energy- and resource-saving technologies in the field of mineral processing, metallurgy and metalworking; – develop measures to protect the environment for processing and metallurgical production; – plan experimental research, select research methods. 4) <i>have the skills</i>: – research activities, solving standard scientific problems; – carrying out educational and pedagogical activities on credit technology of education; - methods of teaching professional disciplines; – use of modern information technologies in the educational process; – professional communication and intercultural communication 5) <i>be competent</i>: - in the field of scientific research methodology; – in the field of scientific and scientific-pedagogical activities in higher educational institutions; - in matters of modern educational technologies; - in carrying out scientific projects and research in the professional field; - in ways to ensure constant updating of knowledge, expansion of professional skills and abilities.
12	Learning outcomes of educational program	Learning outcome 1 To demonstrate communicative, professional and technical language knowledge in English, knowledge of philosophical concepts of natural science, scientific worldview. Learning outcome 2 Integrate psychological patterns of managerial activity. Learning outcome 3 Demonstrate teaching and mentoring skills to undergraduate students. Learning outcome 4 To synthesize the skills of management psychology, critical thinking, leadership, understanding of self-education, personal management, team management, teamwork, establish professional ethics and communication with partners, develop an experiment and analyze with elements of automated process control systems.

	Learning outcome 5 To solve engineering calculations in the field of pyrometallurgical and hydrometallurgical processes and apparatuses, calculate and predict heat and mass transfer processes, analyze thermal modes, simulate heat exchange of metallurgical units using automation systems. Learning outcome 6 Research and make calculations using software on thermodynamics and kinetics of metallurgical processes; to justify the choice of processes and requirements for the hardware design of the technological process. Learning outcome 7 To differentiate methods and means of analysis of metallurgical processes and products, to design powder and composite materials Learning outcome 8 To apply modern, advanced knowledge about innovative technologies of the metallurgical complex: critical technologies in metallurgy, technologies for processing uranium raw materials, resource and energy saving in metallurgy (effective metallurgists), wastewater treatment, obtaining nanostructured materials, waste management, digital control systems in the metallurgical complex Learning outcome 9 To differentiate the modern physico-chemical complex of methods for the analysis of metallurgical raw materials and products, to design powder materials Learning outcome 10 Apply modern, advanced knowledge about innovative technologies for obtaining rare, rare earth and noble metals, light and refractory metals, using resource and energy saving techniques for technological schemes. Learning outcome 11 Rationalize the use of critical, strategic and technogenic raw materials, manage waste from metallurgical production Learning outcome 12 To prevent, predict the problems of corrosion of structures in the metallurgical industry; be aware of various types and types of equipment in the field of metallurgy in order to select the most optimal schemes for their layout and prevent structural problems. Learning outcome 13 Program, develop «MES-systems» for collecting and storing data of technological processes of metallurgy. Learning outcome 14 Systematize the principles of building digital data processing tools, the use of microprocessors in control systems of technical objects and technological processes, design control systems based on microcontrollers, develop application software. Learning outcome 15 Perform analysis of consumer properties of products from energy-generating metals and apply statistical methods of quality management at manufacturing enterprises of the metallurgical industry
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		Learning outcome 16 Investigate non-ferrous metals from various types of natural and man-made raw materials, based on modern problems of metallurgy, materials science and mechanical engineering; apply the technology of metallurgy of alloys based on non-ferrous metals. Learning outcome 17 Calculate and select the main and auxiliary equipment for hydro-, pyro- and electrometallurgical processes in non-ferrous metallurgy, calculate and predict the electro- and metallothermic production of metals and alloys
13	Education form	Full - time
14	Period of training	2 years
15	Amount of credits	120
16	Languages of instruction	Kazakh ,russian, english
17	Academic degree awarded	Master of Technical Sciences
18	Developers and authors	Barmenshinova M.B. Chepushtanova T.A.

4.2. The relationship between the achievability of the formed learning outcomes according to the educational program and academic disciplines

№	Name of the discipline	Brief description of the discipline	Number of credits	Generated learning outcomes (codes)														
				LO1	LO2	LO3	LO4	LO5	LO6	LO7	LO8	LO9	LO10	LO11	LO12	LO13	LO14	LO15
Cycle of basic disciplines University component																		
LNG210	Foreign language (professional)	The course is aimed at studying the main problems of scientific knowledge in the context of its historical development and philosophical understanding, the evolution of scientific theories, principles and methods of scientific research in the historical construction of scientific paintings of the world. The discipline will help to master the skills of developing critical and constructive scientific thinking based on research on the history and philosophy of science. At the end of the course, undergraduates will learn to analyze the ideological and methodological problems of science and engineering and technical activities in building Kazakhstan's science and the prospects for its development.	3	V	V		V											
HUM214	Psychology of management	The course is aimed at mastering the tools for effective employee management, based on knowledge of the psychological mechanisms of the manager's activity. Discipline will help you master the skills of making decisions, creating a favorable psychological climate, motivating employees, setting goals, building a team and communicating with employees. At the end of the course, undergraduates will learn how to resolve managerial conflicts, create	3	V	V		V											

		their own image, analyze situations in the field of managerial activity, as well as negotiate, be stress-resistant and effective leaders.																
HUM212	History and philosophy of science	Purpose: to explore the history and philosophy of science as a system of concepts of global and Kazakh science. Content: the subject of philosophy of science, dynamics of science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy of mathematics, physics, engineering and technology, specifics of engineering sciences, ethics of science, social and moral responsibility of a scientist and engineer.	3	V	V		V											
HUM213	Higher school pedagogy	The course is aimed at mastering the tools for effective employee management, based on knowledge of the psychological mechanisms of the manager's activity. Discipline will help you master the skills of making decisions, creating a favorable psychological climate, motivating employees, setting goals, building a team and communicating with employees. At the end of the course, undergraduates will learn how to resolve managerial conflicts, create their own image, analyze situations in the field of managerial activity, as well as negotiate, be stress-resistant and effective leaders.	3	V		V	V											
Cycle of basic disciplines Elective component																		
MET238	Ecoanalytics and eco-recycling in metallurgy, basics and calculations	The objectives of the course development - the formation of skills to find cost-effective technologies and methods to reduce the emission of harmful substances	5					V	V	V								

		into the environment; to identify and assess environmental risks in the conduct of economic activities in the metallurgical industry; monitoring of the environmental situation at deposits, enrichment and processing plants. Studying the impact of technological processes on the ecosystem; reduction of gaseous emissions from metallurgical enterprises, selection of gas cleaning devices, reclamation of waste dumps, principles for creating environmentally friendly production, reduction of emissions and waste from metallurgy.																
MNG782	Sustainable development strategies	Purpose: To train graduate students in sustainable development strategies to achieve a balance between economic growth, social responsibility, and environmental protection. Content: Graduate students will study the concepts and principles of sustainable development, the development and implementation of sustainable development strategies, the evaluation of their effectiveness, and international standards and best practices. Cases and examples of successful sustainable development strategies are included.	5															
MEI201	Electro- and metallothermic production of metals and alloys	"Electro- and metal-thermal production of metals and alloys Innovative, energy-saving, sparing technological schemes for the electrical production of metals, electrolysis of aluminum and copper. Metal-thermal processes based on the reduction of their oxides and halides by other, more active metals. Modern technological schemes for	5							V			V	V				

		obtaining metals by metallothermic methods, the principles of sparing metallurgy. Obtaining titanium, niobium, tantalum, uranium, REE elements, carbon-free alloys, characterized by high carbon purity by metallothermic methods. Statistics in the production of metals and alloys obtained by electro- and metal-thermal methods. Selection and justification of sparing schemes for the production of refractory metals by metal-thermal methods.															
MEI202	Modern technologies for the production of radioactive metals and alloys	General technological scheme of hydrometallurgical processing of uranium ores. Interaction of leaching reagents with uranium ores, qualitative and quantitative composition of uranium solutions. Theory of ion exchange. Processing of uranium solutions using cationites and anionites. Methods of desorption of uranium from ionites. Equipment of ion exchange processes. Processing of uranium solutions using alkylamines. Processing of uranium solutions using neutral extractants. Selection and justification of sparing production schemes.	5					V	V	V	V						
AUT264	MES systems	The development of the "MES-system" considers data collection and storage, information processing by the data processing subsystem, accumulation and transmission of data and their management circulating in the production environment of the enterprise; product quality management, analysis of product quality measurement data; production process management, monitoring of production processes, automatic correction or dialog support of operator decisions, management	5						V		V					V	V

		maintenance and repair.																
MEI208	Calculations of processes and devices of extractive metallurgy	Features and classification of pyro- and hydrometallurgy devices. Calculations of processes and devices of pyrometallurgical technologies: roasting processes, melting processes, study of modern types of smelting and aggregates in metallurgy of non-ferrous metals. Features and classification of pyro- and hydrometallurgy devices. Calculations of processes and devices of pyrometallurgical technologies: firing processes, melting processes, study of modern types of smelting and aggregates in metallurgy of non-ferrous metals. Equipment for leaching ore and industrial raw materials: vats, reactors, pachukas, autoclaves, percolators, agitators. Features of heap and underground leaching. Equipment for extraction extraction of metals: gravity extractors, mixing and settling equipment, centrifugal extractors, hardware circuits and cascades of extraction processes. Equipment for ion exchange extraction of metals.	5						V		V		V	V				
Cycle of profile disciplines University component																		
MEI203	Thermodynamics and kinetics of pyro- and hydrometallurgy processes	The processes occurring in metallurgical systems will be considered from the standpoint of thermodynamics and kinetics. The characteristics of equilibrium and nonequilibrium processes and states of metallurgical systems are given. Theoretical provisions and conclusions about the structure and properties of metallic, oxide and sulfide systems. Basic calculations on thermodynamics and kinetics of metallurgical processes. Calculation of thermodynamic and kinetic parameters	5						V		V		V	V				

		using modern digital software for calculations.																
MEI204	Gentle metallurgy	The study of methods and technologies for the development of new schemes for the production of metals based on resource savings and environmental protection. Study of modernization of equipment of enterprises that ensure the preservation of environmental priorities and resource conservation. Development of equipment layout schemes based on the balance of ecology, raw materials and energy for its processing, material flows and equipment calculations. The study of technologies aimed at the greening of production (lean technological schemes for the production of heavy non-ferrous metals, energy-generating metals, precious metals), utilization and disposal of metallurgical waste (silicon, pyrite, arsenic-containing, mercury waste). Reducing the "carbon footprint" of technologies.	5					V		V	V			V				
MEI205	Refining and refining in the metallurgy of rare metals	Refining and refining in the metallurgy of rare metals Mineral resource base of rare and rare earth metals. Development of metallurgical assets of the rare metal industry in the world and Kazakhstan. Methods of refining and separation of rare and rare earth metals. Production of refined beryllium, molybdenum, vanadium, rhenium, tantalum and niobium. Separation of rare earth metals. The concept of "refining", refining methods. Refining in the metallurgy of rare metals. Refining of platinum group metals. Selection and justification of sparing production schemes.	5					V	V	V			V					
MEI209	Innovative	Modern trends and schemes of alumina	5					V	V	V			V					

	technologies in metallurgy of light and refractory metals	production; aluminum production. Influence of physico-chemical properties of alumina on technological parameters of aluminum electrolysis. Production of refractory metals: production of metallic titanium, tungsten, metallurgical silicon. FFC Cambridge - process .The Cambridge Process is an electrochemical method for producing titanium from titanium oxide by electrolysis in molten calcium salts. QIT-process (Cardarelli-process). Selection and justification of sparing production schemes.																
MEI210	Rational use of critical and man-made raw materials of the metallurgical industry	Study of the characteristics of complex hard-to-enrich ores; the basics of processing complex multicomponent, hard-to-enrich, as well as pyrite and arsenopyrite containing ores and concentrates are studied. Classification of technogenic metallurgical raw materials and selection of processing schemes. Principles of rationality and complexity of ore and waste processing. The theoretical foundations of autoclave leaching, the principles of various autogenic melting processes are considered, some technologies for processing complex raw materials are considered, the principles of organizing the processes of complex processing of various complex ore and technogenic materials are substantiated. Study of the principles of development of unconventional technologies for processing complex raw materials. Economic efficiency of processing of ore and technogenic raw materials. Selection and justification of sparing production schemes.	5					V		V			V	V				
Cycle of profile disciplines Component of choice																		

MET243	Technology of extracting metals from slag	Purpose: Studying the theory and modern technologies of metal extraction from slags, acquiring skills to solve specific problems on the technology of extraction of copper, lead and other metals from oxide and oxide-sulfide melts (slag, slag and matte melt). Content: Modern ways of processing accumulated and current slag waste. New processes of additional extraction of non-ferrous and valuable metals from slags. Characteristics of non-ferrous and ferrous metallurgy slags, features of structure, forms of non-ferrous and valuable metals in slags. Selection and justification of methods of slag processing, economic analysis and evaluation of possible processing. Waste-free, environmentally friendly technologies of slag processing with complex extraction of valuable metals and the use of demetallized silicate part for the production of building materials.	5					V	V			V	V					
MEI206	Extractive metallurgy (in English)	Modern critical, strategic raw materials of extractive metallurgy (ores of heavy non-ferrous metals, light, rare, energy-generating and precious metals). Modern industrial schemes for the production of heavy non-ferrous metals, light, rare, energy-generating and precious metals). Improvement of existing technologies in the field of greening, thrift and complexity of extraction of related elements. Intensification of pyro- and hydrometallurgy processes, study of problems of reducing the efficiency of industrial circuit processes. Selection and justification of sparing production schemes.	5					V		V	V			V				
MNG705	Project management	Goal: Gaining knowledge about the	5		V		V	V							V			

		components and methods of project management based on modern models and standards. Objectives: study of behavioral models of project-oriented management of business development; mastering international standards PMI PMBOK, IPMA ICB and national standards of the Republic of Kazakhstan in the field of project management; analysis of the features of organizational management of business development through the integration of strategic, project and operational management.																
MET281	Recycling technologies in ferrous and non-ferrous metallurgy	Purpose: Master's students mastering the current level of engineering knowledge in the field of recycling technologies in ferrous and non-ferrous metallurgy. Preparation of master students to work at enterprises, research institutes and laboratories related to recycling of metallurgical wastes. Content: The majority of metallurgical waste is stored in accumulators near populated areas, which creates a threat of soil and water pollution and harms the health of residents and the environment in general. With the increasing tendency to tighten the requirements to ecology, the issue of rational use and recycling of waste and slag generated in metallurgical production is acute. In this regard, the study of the theory and practice of modern processes of recycling of metallurgical waste, which is the disposal of metallurgical enterprises from accumulated and generated production waste with the possibility of recycling products, is the main focus of this course. Taking into account that	5					V			V			V				

		metallurgical production wastes are valuable raw materials for obtaining by-products or for reuse in the technological process, this course will pay special attention to new recycling processes, the application of which are of great interest to the existing large metallurgical plants in Kazakhstan.																
MEI207	Electron beam and plasma remelting in metallurgy	The process of electron beam melting (EBM), application in the titanium industry and refractory metals; remelting and purification under high vacuum. EBM in the production of: ultrapure materials for atomization, electronic alloys and processing of titanium scrap. Investigation of the influence of operational parameters on the technological characteristics of plasma processes; various vacuum-plasma methods, mastering practical skills of working on technological plasma equipment, the use of control and measuring instruments to determine the operational parameters of vacuum-plasma processes. Selection and justification of sparing production schemes.	5					V		V	V			V				
MEI211	Waste management of extractive metallurgy	Acquisition of knowledge on the basics of waste management organization of extractive metallurgical industry, study of classification of metallurgical waste. Study of the safe disposal and disposal of waste, determination of waste disposal without harming public health and causing damage to the environment. Waste disposal at the expense of the manufacturer. Physico-chemical, technological and environmental aspects of processing the most characteristic types of waste in the metallurgical industry.	5					V		V	V			V				

		Selection and justification of technological schemes for processing metal-containing waste. Selection and justification of sparing production schemes.																
MEI212	Problems of corrosion of structures in the metallurgical industry	The study of the interaction of metals with the environment, the mechanism of this interaction; the use of physico-chemical patterns to predict the corrosion resistance of metals, the use of appropriate methods of protection. Classification of corrosion processes. Films on metals. The mechanism of diffusion in protective films. Electrochemical corrosion. Thermodynamics of electrochemical corrosion. Secondary processes and electrochemical products. Classification of protection methods. Methods of protection against chemical and electrochemical corrosion of structures of the metallurgical industry.	5								V		V	V				
MEI213	Modern physico-chemical complex of methods of analysis of metallurgical raw materials and products	Acquisition of knowledge in the field of physico-chemical methods of analysis of metallurgical raw materials and products: X-Ray, electron microscopic analysis method, thermal analysis method, resonance analysis methods. Mastering physical and chemical methods of analysis of metallurgical processes. The basic physico-chemical methods for the study of metallurgical products, methods for measuring high temperatures, viscosity, density, and surface tension of melts are studied.	5					V		V		V						
MEI214	Modern technologies of powder metallurgy	Acquisition of knowledge in the field of production of powder materials, familiarization with their basic properties and methods of production. Production of	5					V		V		V						

		metal powders. Mechanical methods for obtaining powder materials. Preparation of powders by methods of reduction of chemical compounds of metals. Examples of obtaining powdered metals by methods of high-temperature reduction of chemical compounds. Obtaining powder reduction materials from solutions. Properties of metal powders and methods of their control. Sintering of powders. Modeling of the powder production process. Development of new powder materials (design skills of new powder materials). Selection and justification of sparing production schemes.																
AUT286	Microprocessor control systems for technological processes	The use of microprocessors in the management of distributed systems as a means of collecting and primary processing, transmission, transformation, as well as controllers of technological processes has expanded the functionality of sensors, actuators, peripheral and terminal devices. This course discusses the issues, the study of which will give undergraduates the basic knowledge and skills necessary to solve industrial and scientific problems related to the choice of microprocessor control systems.	4		V										V	V	V	
MEI223	Modern technologies of rare, rare earth and precious metals	Acquisition of knowledge in the field of production of powder materials, familiarization with their basic properties and methods of production. Production of metal powders. Mechanical methods for obtaining powder materials. Preparation of powders by methods of reduction of chemical compounds of metals. Examples of obtaining powdered metals by methods of high-temperature reduction of chemical	4					V		V	V		V					

		compounds. Obtaining powder reduction materials from solutions. Properties of metal powders and methods of their control. Sintering of powders. Modeling of the powder production process. Development of new powder materials (design skills of new powder materials). Selection and justification of gentle production schemes.																
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5. Curriculum of educational program



NON-PROFIT JOINT STOCK COMPANY
"KAZAKH NATIONAL RESEARCH TECHNICAL UNIVERSITY NAMED AFTER K.I. SATBAYEV"

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

WORKING CURRICULUM

Academic year

2025-2026 (Autumn, Spring)

Group of educational programs

MI17 - "Metallurgical Engineering"

Educational program

7M07229 - "Extractive metallurgy"

The awarded academic degree

Master of Technical Sciences

Form and duration of study

full time (scientific and pedagogical track) - 2 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				Prerequisite	
									1 course		2 course			
									1 sem	2 sem	3 sem	4 sem		
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)														
CYCLE OF BASIC DISCIPLINES (BD)														
M-1. Module of basic training														
LNG213	Foreign language (professional)		BD, UC	3	90	00/30	60	E	3					
HUM214	Psychology of management		BD, UC	3	90	15/0/15	60	E	3					
MEI238	Ecoanalytics and eco-recycling in metallurgy, basics and calculations	1	BD, CCH	5	150	30/0/15	105	E	5					
MEI201	Electro- and metallothermic production of metals and alloys	1	BD, CCH	5	150	30/0/15	105	E	5					
MNG782	Sustainable development strategies	2	BD, CCH	5	150	30/0/15	105	E	5					
MEI202	Modern technologies for the production of radioactive metals and alloys	2	BD, CCH	5	150	30/0/15	105	E	5					
HUM212	History and philosophy of science		BD, UC	3	90	15/0/15	60	E		3				
HUM213	Higher school pedagogy		BD, UC	3	90	15/0/15	60	E		3				
AUT264	MES systems	1	BD, CCH	5	150	30/0/15	105	E			5			AUT127
MEI208	Calculations of processes and devices of extractive metallurgy	1	BD, CCH	5	150	30/0/15	105	E			5			
M-3. Practice-oriented module														
AAP273	Pedagogical practice		BD, UC	8				R			8			
CYCLE OF PROFILE DISCIPLINES (PD)														
M-2. Module of professional activity														
MEI203	Thermodynamics and kinetics of pyro and hydrometallurgy processes		PD, UC	5	150	30/0/15	105	E	5					
MEI204	Gentle metallurgy		PD, UC	5	150	30/15/0	105	E	5					
MEI205	Refining and refining in metallurgy of rare metals		PD, UC	5	150	30/0/15	105	E		5				
MEI209	Innovative technologies in metallurgy of light and refractory metals		PD, UC	5	150	30/0/15	105	E		5				
MET243	Technology of extracting metals from slag	1	PD, CCH	5	150	30/0/15	105	E		5				MET117, MET123
MEI206	Extractive metallurgy	1	PD, CCH	5	150	30/0/15	105	E		5				
MNG705	Project Management	1	PD, CCH	5	150	30/0/15	105	E		5				
MET281	Recycling technologies in ferrous and non-ferrous metallurgy	2	PD, CCH	5	150	30/15/0	105	E		5				MET223, MET280
MEI207	Electron beam and plasma remelting in metallurgy	2	PD, CCH	5	150	30/0/15	105	E		5				

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named after K.I.SATBAYEV»

MEI210	Rational use of critical and industrial raw materials of the metallurgical industry		PD, UC	5	150	30.0/15	105	E			5	
MEI211	Waste management of extractive metallurgy	1	PD, CCH	5	150	30.0/15	105	E			5	
MEI212	Problems of corrosion of structures in the metallurgical industry	1	PD, CCH	5	150	30.0/15.0	105	E			5	
MEI213	Modern physical and chemical complex of methods of analysis of metallurgical raw materials and products	2	PD, CCH	5	150	30.0/15.0	105	E			5	
MEI214	Modern technologies of powder metallurgy	2	PD, CCH	5	150	30.0/15	105	E			5	
AUT286	Microprocessor control systems of technological processes	1	PD, CCH	4	120	15.0/15.0	90	E			4	ELC162
MEI223	Modern technologies of rare, rare earth and precious metals	1	PD, CCH	4	120	30.0/15	75	E			4	
M-3. Practice-oriented module												
AAP256	Research practice		PD, UC	4				R			4	
M-4. Experimental research module												
AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R	4			
AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R		4		
AAP251	Research work of a master's student, including internship and completion of a master's thesis		RWMS	2				R			2	
AAP255	Research work of a master's student, including internship and completion of a master's thesis		RWMS	14				R			14	
M-5. Module of final attestation												
ECA212	Registration and protection of the master thesis		FA	8							8	
Total based on UNIVERSITY:									30	30	30	30
									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	0	0	0	0
BD	Cycle of basic disciplines	0	20	15	35
PD	Cycle of profile disciplines	0	29	24	53
Total for theoretical training:		0	49	39	88
RWMS	Research Work of Master's Student				24
ERWMS	Experimental Research Work of Master's Student				0
FA	Final attestation				8
TOTAL:					120

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

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_____

