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

DOUBLE DIPLOMA DEGREE PROGRAM
7M07229 – «Extractive metallurgy»
Code and name of educational program

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:	Level 7 - Postgraduate education. Master's degree (based on the completed bachelor's program), practical experience
Level based on IQF:	Level 7 – Conceptual professional and/or scientific knowledge (including innovative) and experience in a specific area and/or at the intersection of areas. Assessment and selection of professional information. Creation of new applied knowledge in a specific area. Identification of sources and search for information necessary for the development of activities
Study period:	2 years
Amount of credits:	120

Almaty 2024

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

Educational program **7M07229 - Extractive Metallurgy**

was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Minutes № 12 dated «22» 04 2024.

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

Minutes № 6 dated «19» 04 2024.

Educational program **7M07229 - Extractive Metallurgy**

was developed by Academic committee based on direction «**Metallurgical Engineering**»

Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairperson of Academic Committee:				
Chepushtanova Tatyana	PhD, Candidate of Technical Sciences, Associate Professor	Head of the Department of Metallurgical processes, Heat engineering and Technologies of special materials	K.I. Satbayev KazNRTU	
Teaching staff:				
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Employers:				
Ospanov Yerzhan	Doctor of Technical Sciences, Academician of KazNAEN, Corresponding Member of KazNEA	Director for Strategic Development of Metallurgy	Kazakhmys Holding LLP	
Mamutova Asem	Master of technical science	President	JSC "Ust-Kamenogorsk titanium and magnesium plant"	
Students				
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F KazNRTU 703-05 Educational program

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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.

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	Level 7 – Postgraduate education. Master's degree (based on the mastered bachelor's degree program), practical experience.
9	The level based on IQF	Level 7 – Conceptual professional and/or scientific knowledge (including innovative) and experience in a particular field and/or at the junction of fields. Evaluation and selection of professional information. Creation of new applied knowledge in a certain field. Identification of sources and search for information necessary for the development of activities
10	Distinctive features of EP	A double diploma degree program jointly with NUST MISIS (Russia). The concept of the educational program differs in that the training is aimed at studying the transformation of existing technologies in the field of non-ferrous metallurgy on the principles of gentle, environmentally friendly, complex processing of raw materials in conditions of depletion of ores

		and waste while digitalizing production.
11	List of competencies of educational program	*1) have an idea:* - 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) know:* – 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) be able to:* – 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) have the skills:* – 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) be competent:* - 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 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 full
14	Period of training	2 years
15	Amount of credits	120
16	Languages of instruction	Kazakh/Russian
17	Academic degree awarded	Master of Technical Sciences
18	Developer(s) and authors	Chepushtanova T.A. Ussoltseva G.A. Sultanbayeva A.B.

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	LO 10	LO 11	LO 12	LO 13	LO 14	LO 15	LO 16	LO 17
Cycle of basic disciplines **University component**																				
LNG213	English (professional)	The course is designed for undergraduates of technical specialties to improve and develop foreign language communication skills in the professional and academic field. The course introduces students to the general principles of professional and academic intercultural oral and written communication using modern pedagogical technologies (round table, debates, discussions, analysis of professionally-oriented cases, design). The course ends with a final exam. Undergraduates also need to study independently (MIS).	5	V	V	V														
HUM214	Management Psychology	The course is aimed at teaching undergraduates the basics of management psychology. It will consider the specifics of management psychology, psychological patterns of managerial activity, personality and its potential in the management system; motivation and effectiveness in the organization, leadership and leadership in modern management of organizations, social group as an object of management, psychological foundations of managerial decision-making, business communication and managerial conflicts, psychology of responsibility, image creation, how an integral part of the culture of	3	V	V		V													

		communication, the psychology of advertising.																		
HUM212	History and philosophy of science	The subject of philosophy of science, dynamics of science, specifics of science, science and pre-science, antiquity and the formation of theoretical 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 intended for undergraduates of the scientific and pedagogical magistracy of all specialties. As part of the course, undergraduates will master the methodological and theoretical foundations of higher school pedagogy, learn how to use modern pedagogical technologies, plan and organize learning and education processes, master the communicative technologies of subject-subject interaction between a teacher and a graduate student in the educational process of a university. Also, undergraduates study human resource management in educational organizations (using the example of a higher school).	3	V		V	V													
Cycle of basic disciplines **Elective component**																				
MET235	Engineering calculations in metallurgy	According to the discipline, methods of thermodynamic, mass transfer and technological calculations in the production of non-ferrous metals are studied, including: issues of choosing a technological scheme and basic	**5**					V	V	V										

		metallurgical aggregates; drawing up material and thermal balances; plotting balance sheets; plotting dependency graphs and diagrams. Examples of drawing up algorithms for engineering calculations in metallurgy, drawing up flowcharts and programs using Excel applications and object-oriented programming languages are considered. Algorithms and programs for planning experiments and processing experimental data are studied																		
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 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.	**5**							V			V							V
MNG782	Sustainable Development Strategies	Purpose: To train graduate students in sustainable development strategies to achieve a balance between economic growth, social responsibility, and	**5**	V	V		V														

		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.																		
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 maintenance and repair.	**5**						V		V						V	V			

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: firing processes, melting processes, the study of modern types of smelting and aggregates in the metallurgy of non-ferrous metals. Equipment for leaching ore and man-made 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**						√		√		√	√						
Cycle of profile disciplines University component																				
MEI203	Thermodynamics and kinetics of pyro- and hydrometallurgy processes	The processes occurring in metallurgical systems are 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 using modern digital software for calculations.	**5**						√		√		√	√						
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 conservation. Study of modernization of equipment of	**5**					√		√	√			√						

		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.																		
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 technologies in metallurgy of light and refractory metals	Modern trends and schemes of alumina 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,	**5**					V	V	V			V							

		metallurgical silicon. FCE Cambridge - Process - The Cambridge Process is an electrochemical method for producing titanium from titanium oxide by electrolysis in molten calcium salts. QUIT-process (Cardarelli-process). Selection and justification of sparing production schemes.																		
MEI210	Rational use of critical and man-made raw materials of the metallurgical industry	Studying the characteristics of complex refractory ores; the basics of processing complex multicomponent, refractory, as well as pyrite and arsenopyrite-containing ores and concentrates are being studied. Classification of technogenic metallurgical raw materials and selection of processing schemes. The theoretical foundations of autoclave leaching, the principles of various autogenous smelting processes are considered, some technologies for processing complex raw materials are considered, and the principles for organizing the processes of complex processing of various complex ore and technogenic materials are substantiated. 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	Technologies for extracting metals from slags	Physico-chemical properties of slags. Selection of slag-forming fluxes for optimal management of metallurgical processing of polymetallic raw materials. The content of valuable metals in the slags of non-ferrous and ferrous metallurgy.	5					V	V			V	V							

		Existing methods of depletion of slags. Selection of technological modes, reagents and equipment for processing non-ferrous metallurgy slags in order to maximize the full extraction of valuable non-ferrous metals with the production of dump slag suitable for use in construction. Ways to reduce the content of non-ferrous metals in the resulting metallurgical slags.																		
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	After successful completion of the discipline, undergraduates will gain knowledge about the key components of project management, with an emphasis on modern behavioral models of project-oriented business development management. The course program is based on the international standards PMI PMBOK, IPMA ICB and national standards of the Republic of Kazakhstan in the field of project management recognized by the business community.	5		V		V	V							V					

		The features of organizational management of business development through projects in the relationship of strategic, project and operational management are studied. The system of practices, methods and procedures used in the innovative activities of organizations is considered, taking into account the psychological aspects of team building, communication and interaction with stakeholders.																		
MET281	Recycling technologies in ferrous and non-ferrous metallurgy	Metallurgical waste. Rational use and recycling of waste and slags. Theory and practice of modern recycling processes of metallurgy waste. Disposal of metallurgical enterprises from accumulated and generated industrial waste. Recycling technology: primary sorting, cleaning, rejection; distribution to production lines; storage of the final product; removal and burial at the landfill.	5					√			√			√						
MEI207	Electron beam and plasma remelting in metallurgy	The process of electron beam melting (ELP), application in the titanium industry and refractory metals; remelting and purification under high vacuum. ELP 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, using control and measuring instruments to determine the operational parameters of vacuum-plasma processes.	5					√		√	√			√						

		Selection and justification of sparing production schemes.																		
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. Selection and justification of technological schemes for processing metal-containing waste. Selection and justification of sparing production schemes.	5					V		V	V			V						
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	Acquisition of knowledge in the field of physico-chemical methods of analysis of	5					V		V		V								

	methods of analysis of metallurgical raw materials and products	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.																			
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 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.	5					V		V		V									
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	4		V											V	V	V			

		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.																		
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 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.	4					V		V	V		V							
National Research Technological University "MISIS", (Moscow, Russia)																				
№	**Name of the discipline**	**Brief description of the discipline**	**Number of credits**	**Generated learning outcomes (codes)**																
				LO 1	**LO 2**	**LO 3**	**LO 4**	**LO 5**	**LO 6**	**LO 7**	**LO 8**	**LO 9**	**LO 10**	**LO 11**	**LO 12**	**LO 13**	**LO 14**	**LO 15**	**LO 16**	**LO 17**
MEI215	Information technology	Formation of theoretical knowledge and practical skills in the field of information technology. Preparation of a specialist for scientific, technical, organizational and methodological activities focused on the search, collection and processing of experimental data using information technology. Strategy for finding new and	5		V										V	V	V			

		improving existing technologies. Fundamentals of statistical analysis. Fundamentals of regression analysis. Fundamentals of statistical processing of experimental data.																		
MEI216	Modern problems of metallurgy, mechanical engineering and materials science	Preparing a student for scientific, technical, organizational and methodological activities focused on the production and research of non-ferrous metals from various types of natural and man-made raw materials, based on an analysis of modern problems in metallurgy, materials science and mechanical engineering. New technologies for processing gold ores and man-made waste. The current state and prospects for the development of metallurgy of alloys based on non-ferrous metals. Alloys of non-ferrous metals obtained by secondary metallurgy.							V				V						V	V
MEI217	Metallurgy of rare earth and radioactive metals. Integrated use of raw materials and waste	Formation of competencies in the field of scientific, technical, organizational and methodological activities focused on the production of rare earth and radioactive rare metals and their compounds from various types of natural and man-made raw materials. Technological, environmental and economic aspects in the complex processing of natural raw materials. Complex uranium ores and concentrates. Complex ores and concentrates of rare earth metals. Forecast of complex raw materials of the near future, compositions, processing methods.	**5**					V	V				V	V						
MEI218	Metallurgy of refractory rare metals. Integrated use of raw	Formation of theoretical knowledge and practical skills in the field of complex processing of raw materials and waste of	**5**					V	V		V		V							

	materials and wastes of refractory rare metals	refractory rare metals: the use of a scientific approach in the complex processing of raw materials and waste of production of refractory rare metals using modern technologies; selection of technological schemes that allow complex use of natural raw materials of refractory rare metals taking into account environmental requirements, economic feasibility and energy conservation; carrying out technological, environmental and economic analyses of the proposed schemes for processing natural raw materials and waste from the production of refractory rare metals.																		
MEI219	Consumer properties of metallurgical products	The study of the total consumer properties of products from energy-generating metals, innovative technologies for their production, properties and characteristics of the final product that meets the requirements of consumers, quality management systems at manufacturing enterprises in the metallurgical industry. Consumer properties of energy-generating metals and innovative products based on them. Production of innovative products based on metallic lithium. Production of innovative products based on uranium. Application of a system of standards for the formulation and implementation of research work for the development of innovative products based on energy-generating metals.	**5**					√			√		√					√		
MEI220	Statistical methods of quality management of metallurgical products	The formation of competencies in accordance with the curriculum, as well as the study by students of modern achievements in the production of precious	**5**					√			√		√					√		

		metals from various types of natural raw materials. Selection of factors in the preparation of experiments. A priori ranking. Mastering the method of finding a generalized optimization parameter. A complete factorial experiment. Gradient method. The method of steep ascent.																		
MEI221	Modern methods and equipment of metallurgy, mechanical engineering and materials science	Preparation of a specialist for scientific, technical, organizational and methodological activities focused on the justification, calculation and selection of the main and auxiliary equipment of hydro-, pyro- and electrometallurgical processes of non–ferrous metallurgy. Devices of pyro-, hydro- and electrometallurgical processes. Calculations of equipment. Calculation of the main parameters of the induction crucible furnace. Technological calculations of ion exchange equipment. Energy and heat balance as the basis for calculating the electrolysis bath.	**5**						V				V						V	V
MEI222	New metallurgical technologies	Formation of competencies in the field of new metallurgical technologies and promising areas of development of technologies for processing raw materials of rare and precious 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. Metallurgy of rare metals: industrial schemes for the production of tungsten, molybdenum, rhenium. Strategy for finding new and improving existing technologies. Industrial schemes for the production of precious	**5**					V		V	V		V							

		metals. Strategy for finding new and improving existing technologies. Principles of lean Research and Development Management.																			

5. Curriculum of educational program

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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board-
Rector of Kazrtu named after K.Satpayev
M.M. Begentaev
04 2024 y.

CURRICULUM
of Educational Program on enrollment for 2024-2025 academic year

Educational program 7M07229 - "Extractive metallurgy"
Group of educational programs M117 - "Metallurgical engineering"

Form of study: full-time | Duration of study: 2 year (autumn) | Academic degree: master of technical sciences

Discipline code	Name of disciplines	Cycle	Total amount in credits	Total hours	Classroom amount lec/lab/pr	SIS (including TSIS) in hours	Form of control	Allocation of face-to-face training based on courses and semesters			
								1 course		2 course	
								1 semester	2 semester	3 semester	4 semester
CYCLE OF BASIC DISCIPLINES (BD)											
M-1. Module of basic training (university component)											
LNG213	English (professional)	BD UC	5	90	0/0/2	60	E	3			
HUM214	Management Psychology	BD UC	3	90	1/0/1	60	E	3			
HUM212	History and philosophy of science	BD UC	3	90	1/0/1	60	E		3		
HUM213	Higher school pedagogy	BD UC	3	90	1/0/1	60	E		3		
component of choice											
MEI238	Ecoanalytics and eco-recycling in metallurgy, basics and calculations	BD CC	5	150	2/0/1	105	E	5			
MEI201	Electro- and metallothermic production of metals and alloys				2/0/1	105					
MNG782	Sustainable Development Strategies	BD CC	5	150	2/0/1	105	E	5			
MEI202	Modern technologies for the production of radioactive metals and alloys				2/0/1	105					
AUT264	MES systems	BD CC	5	150	2/0/1	105	E			5	
MEI208	Calculations of processes and devices of extractive metallurgy				2/0/1	105					
CYCLE OF PROFILE DISCIPLINES (PD)											
M-2. Module of professional activity (university component, component of choice)											
MEI203	Thermodynamics and kinetics of pyro- and hydrometallurgy processes	PD UC	5	150	2/0/1	105	E	5			
MEI204	Gentle metallurgy	PD UC	5	150	2/1/0	105	E	5			
MEI205	Refining and refining in the metallurgy of rare metals	PD UC	5	150	2/0/1	105	E		5		
MEI209	Innovative technologies in metallurgy of light and refractory metals	PD UC	5	150	2/0/1	105	E		5		
MEI210	Rational use of critical and man-made raw materials of the metallurgical industry	PD UC	5	150	2/0/1	105	E			5	
MET243	Technologies for extracting metals from slags	PD CC	5	150	2/0/1	105	E		5		
MEI206	Extractive metallurgy										
MNG705	Project management										
MET281	Recycling technologies in ferrous and non-ferrous metallurgy	PD CC	5	150	2/1/0	105	E		5		
MEI207	Electron beam and plasma remelting in metallurgy				2/0/1						
MEI211	Waste management of extractive metallurgy	PD CC	5	150	2/0/1	105	E			5	
MEI212	Problems of corrosion of structures in the metallurgical industry				2/1/0						
MEI213	Modern physico-chemical complex of methods of analysis of metallurgical raw materials and products	PD CC	5	150	2/1/0	105	E			5	
MEI214	Modern technologies of powder metallurgy				2/0/1						
AUT286	Microprocessor control systems for technological processes	PD CC	4	120	1/1/0	75	E				4
MEI223	Modern technologies of rare, rare earth and precious metals				2/0/1						
M-3. Practice-oriented module											
AAP273	Pedagogical practice	BD UC	8							8	
AAP256	Research practice	PD, UC	4								4
M-4. Experimental research module											
AAP268	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	4					4			
AAP268	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	4						4		
AAP251	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	2							2	
AAP255	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	14								14
M-5. Module of final attestation											
ECA212	Preparation and defense of a master's thesis	FA	8								8
	Total based on UNIVERSITY:							30	30	30	30
								60		60	

National Research Technological University "MISIS", (Moscow, Russia)

M-2. Module of basic training and professional activity (university component, component of choice)											
MEI234	Foreign language	BD UC	3		0/0/3		E	3			
MEI224	Writing scientific articles for scientific journals / Academic Research and Writing	BD UC	2		0/0/2		E	2			
MEI225	Engineering calculations in metallurgy	BD UC	6		2/0/4		E	6			
MEI226	Metallurgy of rare earth and radioactive metals. Production of rare earth and radioactive metals	BD UC	8		2/2/4		E	8			
MEI227	Theory and technology of hydrometallurgical productions	PD UC	4		1/1/2		E	4			
MEI228	New metallurgical technologies, part 1.	PD UC	3		1/0/2		E	3			
MEI229	Protection of intellectual property	BD UC	3		0/0/3		E		3		
MEI230	Methodology of scientific research.	BD UC	3		2/0/1		E		3		
MEI231	Modeling and optimization of technological processes	PD UC	6		2/2/2		E		6		
MEI232	Project management	PD UC	3		1/1/1		E		3		
MEI233	Metallurgy of secondary light metals. Primary processing of scrap and non-ferrous metal waste.	PD UC	8		2/0/6		E		8		
MEI215	Information technology	BD UC	5	150	2/1/0	105	E			5	
MEI216	Modern problems of metallurgy, mechanical engineering and materials science				2/0/1						
MEI217	Metallurgy of rare earth and radioactive metals. Integrated use of raw materials and waste	PD UC	5	150	2/0/1	105	E			5	
MEI218	Metallurgy of refractory rare metals. Integrated use of raw materials and wastes of refractory rare metals	PD UC	5	150	2/0/1	105	E			5	
MEI219	Consumer properties of metallurgical products	PD CCH	5	150	2/0/1	105	E			5	
MEI220	Statistical methods of quality management of metallurgical products										
MEI221	Modern methods and equipment of metallurgy, mechanical engineering and materials science	PD CCH	5	150	2/0/1	105	E			5	
MEI222	New metallurgical technologies										
M-3. Practice-oriented module											
MEI236	Scientific research practice	PD UC	4					4			
MEI237	Scientific research practice	PD UC	7						7		
AAP274	Research practice	PD UC	8								8
M-4. Experimental research module											
AAP254	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	5							5	
AAP255	Research work of a master's student, including internship and completion of a master's thesis	RWMS UC	14								14
M-5. Module of final attestation											
ECA212	Preparation and defense of a master's thesis	FA	8								8
								30	30	30	30
								60		60	

Number of credits for the entire period of study					
Cycle code	Cycles of disciplines	Credits			
			university component (UC)	component of choice (CCH)	Total
BD	Cycle of basic disciplines		20	15	35
PD	Cycle of profile disciplines				53
	Total for theoretical training:	*0*	*53*	*35*	*88*
	RWMS				*24*
FA	Final attestation	12			8
	TOTAL:	12	53	35	120

Decision of the Academic Council of Kazatu named after K.Satpayev. Protocol №12-22-04 2024 y.

Decision of the Educational and Methodological Council of Kazatu named after K.Satpayev. Protocol №6 -19-04 2024 y.

Decision of the Academic Council of the Institute Mining and Metallurgical. Protocol №7 25-03 2024 y.

Vice-Rector for Academic Affairs — Uskenbayeva R. K.

Vice-Rector for Education
National Research Technological University MISIS — Volkov A.A.

Institute Director — Rysbekov K.B.

Department Head MP,HEandTSM — Chepushtanova T.A.

Partner university:
Worcester Polytechnic Institute (USA) — B. Mishra

The representative of the Specialty Council from the employers of Kazakhmys LLP — Ospanov.E.A.