Mining and Metallurgical Institute named after O.A. Baikonurov

Department of Metallurgical processes, heat engineering and technology of special materials

EDUCATIONAL PROGRAM

8D07213 - Extractive metallurgy and advanced materials

Code and classification of the field of education	8D07 – Engineering, manufacturing and construction industries
Code and classification of training directions	8D072 – Industrial and manufacturing branches
Educational program group	D117 – Metallurgical engineering
The level based on NQF	Level 8 – Postgraduate education (programs leading to the academic degree of Doctor of Philosophy (PhD) and doctors in profile and/or practical experience)
The level based on IQF	Level 8 – Knowledge at the most advanced level in the field of science and professional activity
Period of training	3 years
Amount of credits	180

Almaty 2024

Educational program **«8D07213 - Extractive metallurgy and advanced materials»** was approved at the meeting of K.I. Satbayev KazNRTU Academic Council.

Minutes № 17 dated «11» 07 2024

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

Minutes № 8 dated «05» 07 2024.

Educational program **8D07213 - Extractive metallurgy and advanced materials** 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 MPHaTSM	KazNRTU	
Teaching staff:				
Mamyrbayeva Kulzira	PhD	Associate Professor of the Department of MPHaTSM	KazNRTU	
Ussoltseva Galina	Candidate of Technical Sciences	Associate Professor of the Department of MPHaTSM	KazNRTU	
Employers:				
Yerzhan Ospanov	Doctor of technical sciences	Director of Strategic Development of Metallurgy	«Kazakhmys Corporation» LLP	
Students				
Sarsembayeva Marzhan	2nd year doctor's student	Doctoral candidate	KazNRTU	

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List of abbreviations and designations

SMSERK – The State mandatory standard of Education of the Republic of Kazakhstan;

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

EP – educational program;

SIS – independent work of a student (student, master's student, doctoral student);

TSIS – independent work of a student with a teacher (independent work of a student (master's student, doctoral student) with a teacher);

WC – working curriculum;

CES – catalog of elective subjects;

UC – the 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

It is intended for the specialized training of doctoral students in the educational program 8D07213 - Extractive Metallurgy and advanced materials at Satbayev University and was developed within the framework of the direction "Manufacturing and processing industries".

The educational program 8D07213 – Extractive Metallurgy and Advanced Materials focuses on the training of highly qualified scientific and engineering personnel with advanced knowledge in the theory and practice of processing ore and man-made resources, as well as the development of innovative materials for modern industry, in accordance with the goals of sustainable development and the ESG concept. The program covers the full cycle of extractive metallurgy, from the extraction and processing of raw materials to the production of end products with high added value.

An innovative, specialized educational program focused on the industrial need for personnel, including experimental and production activities in the field of extractive metallurgy and the production of advanced materials in metallurgical processing; including training in the field of sustainable development of extractive metallurgy, extraction of strategic metals, production of advanced high-grade products; improving the efficiency of processing rare metal and uranium raw materials, the production of advanced materials such as the production of uranium hexafluoride, the production of uranium dioxide powder; production of refractory metals and alloys, production of advanced materials from raw materials containing refractory metals; electro-extraction process, production of cathode copper, acquisition of skills in using process intensification methods; in the field of 3D technologies and additive manufacturing of metal products; in the field of conversion processes and fluoride technologies in the uranium industry, production of advanced materials the uranium industry. The graduate is awarded the degree of Doctor of PhD in the profile.

The 8D07213 educational program reflects the concept of strategic metals for Kazakhstan and the global industry, technologies for extracting metals that make up the need for low-carbon energy, the formation of priority technologies for extracting strategic metals using extractive metallurgy methods, the principles of sustainable development of extractive metallurgy, calculations of the carbon footprint, carbon and sulfur-containing gases emissions, obtaining advanced products (advanced materials) of high-grade rare metal and rare earth raw materials.

A distinctive feature of the specialized doctoral program is that the Program has been developed taking into account advanced global trends such as "Green Metallurgy", digitalization of production processes, sustainable development and transition to waste-free technologies. It integrates the latest concepts of the atlas of new professions in the field of gentle metallurgy and focuses on the development strategy of advanced materials, including fluoride technologies, intelligent and self-adapting materials, nanostructured and biocompatible materials, as well as products from the uranium industry.

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 in the framework of legislative amendments to enhance the independence and autonomy of universities dated 07/04/18 No. 171-VI;

– The Law of the Republic of Kazakhstan "On Amendments and Additions to Certain Legislative Acts of the Republic of Kazakhstan on the expansion of academic and managerial independence of higher education institutions" dated 07/04/18. No. 171-VI;

– Order of the Minister of Education and Science of the Republic of Kazakhstan dated 10/30/18 No. 595 "On approval of Standard Rules for the activities of educational organizations of relevant types";

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

– Resolution of the Government of the Republic of Kazakhstan dated January 19, 12, No. 111 "On approval of the Standard Rules for admission to study in educational organizations implementing educational programs of higher education" with amendments and additions dated July 14, 2016, No. 405;

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

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

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

– Industry qualification framework "Mining and Metallurgical Complex" No. 1 dated 30.07.2019;

– President Kassym-Jomart Tokayev's Messages to the People of Kazakhstan: September 2, 2024: "Fair Kazakhstan: law and order, economic growth, public optimism"; September 1, 2023: "Economic Course of Fair Kazakhstan"; September 1, 2022: "Fair State. One nation. A prosperous society."

Introduction to the educational program. The program includes an in-depth study of advanced technologies in hydrometallurgy and biometallurgy, plasma and electromagnetic methods of processing raw materials, supercritical fluid extraction technologies, and fluoride technologies. Special attention is paid to the modeling and digital counterparts of metallurgical processes, the development of new catalysts and functional coatings to increase the energy efficiency of production.

The program is aimed at developing competencies in the field of materials with programmable properties, additive technologies, as well as the introduction of artificial intelligence into the management processes of metallurgical plants. A

significant part of the training is based on interdisciplinary research combining nanotechnology, materials science, machine learning and chemical engineering.

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

Figure 1 - The concept of scientific and educational programs

Key areas of training:

• Modern technologies for processing mineral raw materials and secondary resources, including hydro, pyro, and electrometallurgical processes;

• Development of advanced materials for aviation, space, energy, biomedical and other high-tech industries;

• Clean and resource-saving technologies in metallurgy, including carbon capture and utilization;

• Additive technologies and nanomaterials, including 3D printing of metals and alloys;

• Development of intelligent and programmable materials with specified properties;

• Fundamentals of artificial intelligence and digital twins in metallurgy, process modeling based on Phyton and Big Data, and machine learning;

• Environmental aspects of metallurgical production, including restoration of polluted territories and innovative methods of waste disposal, compliance with the principles of gentle metallurgy;

• Metallurgy of rare, RM and REM metals of strategically important and critically necessary metals, radioactive metals, including processing of man-made waste and secondary resources.

Types of work activity. Specialists who have completed their doctoral studies carry out production, technological and organizational work at industrial enterprises in leading positions corresponding to the 8th level of the national qualification framework, as well as conduct research in the field of complex processing of mineral

raw materials and the production of innovative products with increased consumer properties, in the field of advanced materials.

Types of economic activity: mining of metal ores; mining of uranium ore; mining of RM and REM metals; mining of non-ferrous metals; mining of uranium and thorium ore; mining of uranium and thorium ore; mining of ores of other non-ferrous metals; mining and processing of aluminum-containing raw materials; mining and processing of copper ore; mining and processing of leadzinc ore; extraction and enrichment of nickel-cobalt ores; extraction and enrichment of titanium-magnesium raw materials (ores); production of advanced materials based on RM and REM metals, as well as uranium.

Objects of professional activity. The objects of professional activity of graduates are enrichment plants, enterprises of ferrous and non-ferrous metallurgy, chemical, mining, chemical and machine-building industries, branch research and design institutes, factory laboratories, higher educational institutions, consulting companies, scientific and innovation centers, banks.

Professional competencies of graduates:

• The ability to develop and implement advanced technologies for processing raw materials and secondary resources using innovative metallurgical methods;

• Deep knowledge in the field of extractive metallurgy and advanced materials production, including the principles of creating intelligent, nanostructured and biocompatible materials;

• Skills in working with digital twins and modeling metallurgical processes using artificial intelligence and machine learning technologies;

• Competence in the development of environmentally friendly and energy-efficient metal processing technologies;

• Proficiency in experimental and theoretical research methods, including spectroscopy, electron microscopy, and X-ray diffraction;

• The ability to analyze the economic efficiency of innovative metallurgical processes and assess their impact on the environment;

• Ability to develop technological solutions for industrial implementation in cooperation with leading international companies and scientific centers;

• Readiness for research and development, publication of results in leading peer-reviewed journals and participation in international conferences, commercialization of projects;

• Project management skills in the metallurgical and materials sciences, including the implementation of interdisciplinary projects and work in international research groups.

2 Purpose and objectives of educational program

The purpose of the EP is to form knowledge about the sustainable development of extractive metallurgy, the extraction of strategic metals, and the production of high-grade advanced materials from rare metal and rare earth raw materials.

The Metallurgical Engineering educational program is aimed at training specialists capable of developing and implementing environmentally sound and resource-saving technologies in metallurgy within the framework of the ESG and the Sustainable Development Goals (SDGs).

The objectives of OP 8D07213 are developed on the basis of the ESG concept and the Sustainable Development Goals, and include energy and resource conservation:

– Development of innovative methods of extractive metallurgy and production of advanced materials focused on production needs.

– Formation of doctoral students' skills in experimental production activities, including in the field of processing rare metal and uranium raw materials.

– Training of specialists in the field of sustainable development of metallurgy, extraction of strategic metals and creation of highly processed products.

– Improving the efficiency of the processing of uranium raw materials, developing technologies for the production of uranium hexafluoride and uranium dioxide powder.

– Development of competencies in the field of production of refractory metals and alloys, as well as advanced materials based on them.

– Development of electroextraction methods and technologies for obtaining cathode copper using process intensification.

– Training of specialists in the field of 3D technologies and additive manufacturing of metal products.

– Study of conversion processes and fluoride technologies in the uranium industry in order to obtain advanced materials for the nuclear industry.

– assessment of innovation and technological risks in the implementation of new technologies;

– competence in marketing high-tech technologies;

– development of personal scientometric indicators of the student;

– International internship.

Thus, the program is aimed at creating a sustainable and technologically advanced metal production that meets the requirements of environmental safety and innovative development.

3. Requirements for evaluating the educational program learning outcomes

Persons who have received a PhD degree, in order to deepen their scientific knowledge, solve scientific and applied problems on a specialized topic, carry out a postdoctoral program or conduct scientific research under the guidance of a leading scientist of a chosen university.

A graduate of a scientific and pedagogical doctoral program must:

1) have an idea of:

– the main stages of development and paradigm shift in the evolution of science;

– on the subject, ideological and methodological specifics of the natural (social, humanitarian, economic) sciences;

– about scientific schools of the relevant branch of knowledge, their theoretical and practical developments;

– about scientific concepts of world and Kazakh science in the relevant field;

– on the mechanism of implementation of scientific developments in practical activities;

– on the norms of interaction in the scientific community;

– about the pedagogical and scientific ethics of a research scientist;

2) know and understand:

– current trends, trends and patterns of development of Russian science in the context of globalization and internationalization;

– methodology of scientific knowledge;

– achievements of world and Kazakh science in the relevant field;

– (realize and accept) the social responsibility of science and education;

– perfect foreign language for scientific communication and international cooperation;

3) be able to:

– to organize, plan and implement the scientific research process;

– analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions;

– analyze and process information from various sources;

– to conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis;

– generate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge;

– to choose and effectively use modern research methodology;

– plan and predict your further professional development*;*

4) have the skills:

– Conducting complex laboratory and industrial experiments on the processing of raw materials and the synthesis of new materials;

– Data analysis using modern big data processing tools (Big Data) and artificial intelligence;

– Application of mathematical modeling and numerical analysis methods to optimize metallurgical processes;

– Mastery of methods of non-destructive testing and diagnostics of the structure of materials;

– Development of new technological solutions to improve energy efficiency and environmental safety of metallurgical production;

– The introduction of additive technologies and 3D printing in the production of metal products;

– Skills in working with automated metallurgical process control systems;

– Development of new functional coatings and catalysts to improve the properties of materials;

– Optimization of technological processes based on sustainable development and principles of circular economy;

– Conducting scientific research and presenting their results in the form of reports, articles and patents.

5) be competent:

– in the field of scientific and scientific-pedagogical activity in conditions of rapid updating and growth of information flows;

– in carrying out theoretical and experimental scientific research;

– in setting and solving theoretical and applied problems in scientific research;

– to conduct a professional and comprehensive analysis of problems in the relevant field;

– in matters of interpersonal communication and human resource management;

– in matters of university training of specialists;

– in carrying out the expertise of scientific projects and research;

– to ensure continuous professional growth.

4. Passport of educational program

4.1. General information

№	Field name	Comments
1	Code and classification of the field of education	8D07 – Engineering, manufacturing and construction industries
2	Code and classification of training directions	8D072 – Industrial and manufacturing branches
3	Educational program group	D117 – Metallurgical Engineering
4	Educational program name	«8D07213 - Extractive metallurgy and advanced materials»
5	Short description of educational program	The educational program «8D07213 – Extractive Metallurgy and Advanced Materials» focuses on the training of highly qualified scientific and engineering personnel with advanced knowledge in the theory and practice of processing ore and man-made resources, as well as the development of innovative materials for modern industry, in accordance with the goals of sustainable development and the ESG concept. The program covers the full cycle of extractive metallurgy, from the extraction and processing of raw materials to the production of end products with high added value.
6	Purpose of EP	The Metallurgical Engineering educational program is aimed at training specialists capable of developing and implementing environmentally sound and resource-saving technologies in metallurgy within the framework of the ESG and the Sustainable Development Goals (SDGs).
7	Type of EP	Current

8	The level based on NQF	Level 8 – Postgraduate education (programs leading to the academic degree of Doctor of Philosophy (PhD) and doctors in profile and/or practical experience)
9	The level based on IQF	Level 8 – Knowledge at the most advanced level in the field of science and professional activity
10	Distinctive features of EP	A distinctive feature of the specialized doctoral program is that the Program has been developed taking into account advanced global trends such as "Green Metallurgy", digitalization of production processes, sustainable development and transition to waste-free technologies. It integrates the latest concepts of the atlas of new professions in the field of gentle metallurgy and focuses on the development strategy of advanced materials, including fluoride technologies, intelligent and self-adapting materials, nanostructured and biocompatible materials, as well as products from the uranium industry.
11	List of competencies of educational program	*1) have an idea of:* – the main stages of development and paradigm shift in the evolution of science; – on the subject, ideological and methodological specifics of the natural (social, humanitarian, economic) sciences; – about scientific schools of the relevant branch of knowledge, their theoretical and practical developments; – about scientific concepts of world and Kazakh science in the relevant field; – on the mechanism of implementation of scientific developments in practical activities; – on the norms of interaction in the scientific community; – about the pedagogical and scientific ethics of a research scientist; *2) know and understand:* – current trends, trends and patterns of development of Russian science in the context of globalization and internationalization; – methodology of scientific knowledge; – achievements of world and Kazakh science in the relevant field; – (realize and accept) the social responsibility of science and education; – – perfect foreign language for scientific communication and international cooperation; *3) be able to:* – to organize, plan and implement the scientific research process; – analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions; – analyze and process information from various sources; – to conduct independent scientific research, characterized by academic integrity, based on modern theories and methods of analysis; – generate your own new scientific ideas, communicate your knowledge and ideas to the scientific community, expanding the boundaries of scientific knowledge; – to choose and effectively use modern research methodology; – plan and predict your further professional development; *4) have the skills:*

		– conducting complex laboratory and industrial experiments on the processing of raw materials and the synthesis of new materials; – data analysis using modern big data processing tools (Big Data) and artificial intelligence; – application of mathematical modeling and numerical analysis methods to optimize metallurgical processes; – mastery of methods of non-destructive testing and diagnostics of the structure of materials; – development of new technological solutions to improve energy efficiency and environmental safety of metallurgical production; – the introduction of additive technologies and 3D printing in the production of metal products; – skills in working with automated metallurgical process control systems; – development of new functional coatings and catalysts to improve the properties of materials; – optimization of technological processes based on sustainable development and principles of circular economy; – conducting scientific research and presenting their results in the form of reports, articles and patents. *5) be competent:* – in the field of scientific and scientific-pedagogical activity in conditions of rapid updating and growth of information flows; – in carrying out theoretical and experimental scientific research; – in setting and solving theoretical and applied problems in scientific research; – to conduct a professional and comprehensive analysis of problems in the relevant field; – in matters of interpersonal communication and human resource management; – in matters of university training of specialists; – in carrying out the expertise of scientific projects and research; to ensure continuous professional growth.
12	Learning outcomes of educational program	LO1 – possess knowledge in the field of theoretical foundations of the rational use of natural resources, raw material processing, and products, as well as the ability and skills to restructure professional activities, implement original innovative ideas in education, find non-standard and alternative solutions, and generate new ideas with critical thinking. LO2 – are able to apply fundamental general engineering knowledge, critically evaluate accumulated experience, change the profile of their professional activities if necessary, and combine theory and practice to create sustainable engineering solutions. LO3 – are able to apply applied software tools and modern methods of information processing. LO4 – apply priority technologies for the extraction of strategic metals by methods of extractive metallurgy to implement the development of innovative infrastructure. LO5 – are able to apply methods for improving the efficiency of processing rare metal and uranium raw materials, obtaining

		advanced materials from rare metal and uranium raw materials in accordance with the clean energy concept of the SDG. LO6 – possess innovative systems, technologies, and methods for obtaining refractory metals and alloys. LO7 – develop knowledge and skills in the field of 3D technologies and additive manufacturing of metal products within the framework of the SDG activities. LO8 – independently conduct scientific research in the field of conversion processes and fluoride technologies in the uranium industry to implement sustainable development. LO9 – possess knowledge, skills, and abilities to manage information, conduct comprehensive monitoring, analysis, and synthesis, strive for continuous improvement of research culture, and master the fundamental laws of basic disciplines applied to the description and modeling of metallurgical technological processes.
13	Education form	Full-time
14	Period of training	3 years
15	Amount of credits	180
16	Languages of instruction	Kazakh/Russian
17	Academic degree awarded	PhD doctor
18	Developer(s) and authors	Chepushtanova T.A., Barmenshinova M.B.

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

№	Discipline name	Short description of discipline	Amount of credits	Generated learning outcomes (codes)								
				PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
Cycle of basic disciplines University component												
MET322	Methods of scientific research	Purpose: It consists in mastering knowledge about the laws, principles, concepts, terminology, content, specific features of the organization and management of scientific research using modern methods of scientometry. Contents: structure of technical sciences, application of general scientific, philosophical and special methods of scientific research, principles of organization of scientific research, methodological features of modern science, ways of development of science and scientific research, the role of technical sciences, computer science and engineering research in theory and practice.	5	V	V	V						
LNG305	Academic writing	Objective: to develop academic writing skills and writing strategies for doctoral students in engineering and natural sciences. Content: fundamentals and general principles of academic writing, including: writing effective sentences and paragraphs, writing an abstract, introduction, conclusion, discussion, and references; in-text citation; preventing plagiarism; and preparing a conference presentation.	5	V	V	V						
Cycle of basic disciplines Component of choice												
MET336	Sustainable development of extractive metallurgy,	Purpose: formation of knowledge about the sustainable development of extractive metallurgy, extraction of strategic metals, production of	5	V			V					V

	extraction of strategic metals, production of advanced high-value products	advanced products (advanced materials) of high processing from rare metal and rare earth raw materials. Contents: the concept of strategic metals for Kazakhstan and the global industry, technologies for the extraction of metals that constitute the need for low-carbon energy, the formation of priority technologies for the extraction of strategic metals using extractive metallurgy methods, the principles of sustainable development of extractive metallurgy, calculations of the carbon footprint, emissions of carbon and sulfur-containing gases, obtaining advanced products (advanced materials) high processing stages of rare metal and rare earth raw materials.										
MET337	Increasing the efficiency of processing rare metal and uranium raw materials, obtaining advanced materials	Purpose: developing knowledge about methods for increasing the efficiency of processing rare metal and uranium raw materials, obtaining advanced materials from rare metal and uranium raw materials. Contents: methods for increasing the efficiency of processing rare metal and uranium raw materials, obtaining advanced materials from rare metal and uranium raw materials: obtaining uranium hexafluoride, obtaining uranium dioxide powder; obtaining products in the form of powders and materials from lithium, beryllium, gallium, indium, germanium, vanadium, titanium, molybdenum, tungsten and rare earth elements, new composite materials.	5	V				V				V
MNG349	Intellectual property and the global market	Purpose: the goal is to train specialists in the field of intellectual property law who can analyze and predict trends in its development in the global market, develop strategies for the protection and commercialization of intellectual property.	5	V	V	V						V

		Contents: global aspects of intellectual property and its role in international trade and economics, analysis of international agreements and conventions, IP management strategies, cases of protection and violation of intellectual property rights in various jurisdictions.										
Cycle of profile disciplines Component of choice												
MET338	Innovative technologies for producing refractory metals and alloys, advanced materials	Purpose: to develop knowledge about innovative technologies for producing refractory metals and alloys, producing advanced materials from raw materials containing refractory metals. Content: innovative technologies and methods for producing refractory metals and alloys, high-temperature synthesis of refractory compounds based on SHS technologies, vacuum-arc processes. Production of advanced materials from raw materials containing refractory metals: production of titanium alloys by vacuum arc; obtaining thin coatings from titanium carbides and nitrides, molybdenum and hafnium carbides, etc., two-layer or three-layer coatings of composition (TiC, Ti (CN), TiN); obtaining tungsten products.	5			√			√			√
MET341	SX-EW technology, problems and decisions	Purpose: developing knowledge about the process of electro-extraction, obtaining cathode copper, gaining skills in using methods of process intensification. Contents: SX-EW technology (solvent extraction-electrolysis) is a copper cathode production technology. Increasing the efficiency of SX-EW technology, the method of leaching in atmospheric conditions, solving the problem of theft formation, increasing the efficiency of using reagents, modernizing equipment, reducing the influence of	5	√	√	√						√

		impurities on the copper extraction process. Methods for intensifying the production of cathode copper using electrolysis methods.										
MET339	3D technologies and additive manufacturing of metal products	Purpose: developing knowledge and skills in the field of 3D technologies and additive manufacturing of metal products Content: 3D technologies in metallurgy, additive manufacturing of metal products, laser additive manufacturing technologies of metal products, electron beam melting (EBM) of titanium, metal powders for additive technologies, titanium powders, 3D technology products from metal-containing powders, production of fine metal powder, production of metal high-alloy powders for surfacing, spraying and additive technologies.	5	V								V
MET340	Conversion processes and fluoride technologies in the uranium industry, advanced materials of the uranium industry	Purpose: developing knowledge and skills in the field of conversion processes and fluoride technologies in the uranium industry, obtaining advanced materials for the uranium industry Contents: conversion processes and fluoride technologies in the uranium industry, chemical-technological process of converting uranium-containing materials - uranium oxides into uranium hexafluoride, fluoride technologies, production of advanced materials in the uranium industry: production of uranium oxides, uranium hexafluorides, production of metallic uranium and its alloys, production of products from powdered uranium, production of uranium-based composite materials, production of fuel elements for nuclear reactors, production of metal fuel rods.	5		V						V	V

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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board -
Rector of KazNRTU named after K.Satpayev
_____ M.M. Begentayev
«___» _____ 2024 г.

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

Educational program 8D07213 - "Extractive metallurgy and advanced materials"
Group of educational programs D117 - "Metallurgical engineering"

Form of study: full-time **Duration of study: 3 year** **Academic degree: Doctor by profile**

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					
								1 course		2 course			
								1 semester	2 semester	3 semester	4 semester	5 semester	6 semester
CYCLE OF BASIC DISCIPLINES (BD)													
M-1. Module of basic training (university component)													
MET322	Scientific research methods	BD UC	5	150	2/0/1	105	E	5					
LNG305	Academic writing	BD UC	5	150	0/0/3	105	E	5					
component of choice													
MET336	Sustainable development of extractive metallurgy, extraction of strategic metals, production of advanced high-value products	BD CCH	5	150	2/0/1	105	E	5					
MET337	Increasing the efficiency of processing rare metal and uranium raw materials, obtaining advanced materials												
MNG349	Intellectual property and the global market												
CYCLE OF PROFILE DISCIPLINES (PD)													
M-2. Module of professional activity (component of choice)													
MET338	Innovative technologies for producing refractory metals and alloys, advanced materials	PD, CCH	5	150	2/0/1	105	E	5					
MET341	SX-EW technology, problems and decisions				2/1/0								
MET339	3D technologies and additive manufacturing of metal products	PD, CCH	5	150	2/1/0	105	E	5					
MET340	Conversion processes and fluoride technologies in the uranium industry, advanced materials of the uranium industry				2/0/1								
M-3. Practice-oriented module													
AAP371	Industrial intership	PD UC	20						20				
M-4. Experimental research module													
AAP372	Experimental research work of doctoral student, including internships and doctoral dissertations	ERWDS UC	5					5					
AAP376	Experimental research work of doctoral student, including internships and doctoral dissertations	ERWDS UC	10						10				
AAP374	Experimental research work of doctoral student, including internships and doctoral dissertations	ERWDS UC	90							30	30	30	
AAP375	Experimental research work of doctoral student, including internships and doctoral dissertations	ERWDS UC	18										18
M-5. Module of final attestation													
ECA303	Writing and defending a doctoral dissertation	FA	12										12
Total based on UNIVERSITY:								30	30	30	30	30	30
								60		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		10	5	15
PD	Cycle of profile disciplines		20	10	30
	Total for theoretical training:	*0*	*30*	*15*	*45*
	ERWDS				*123*
FA	Final attestation	12			12
	TOTAL:	12	30	15	180

Decision of the Academic Council of Kaznu named after K.Satpayev. Protocol № 17 "11" __07____2024_y.

Decision of the Educational and Methodological Council of Kaznu named after K.Satpayev. Protocol № 8 "5" __07___2024__ y.

Decision of the Academic Council of the Institute MML Protocol № 10 "26" ___06___2024_y.

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

Institute Director — **Rysbekov K.B.**

Department Head MP,HEandTSM — **Chepushtanova T.A.**

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

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