Mining and Metallurgical Institute named after O.A. Baikonurov
Department of «Metallurgy and Mineral Processing»

EDUCATIONAL PROGRAM

8D07201 - Mineral processing

Code and classification of the field of education:	8D07 – Engineering, manufacturing and construction industries
Code and classification of training areas:	8D072 – Manufacturing and processing industries
Group of educational programs:	D118 – Mineral processing
The level of the NRK:	Level 8 – Postgraduate education (programs leading to the academic degree of Doctor of Philosophy (PhD) and doctors in the profile and/or practical experience)
ORC Level:	Level 8 – Knowledge at the most advanced level in the field of science and professional activity. Use specialized knowledge for critical analysis, evaluation and synthesis of new complex ideas that are at the cutting edge of this field. Evaluation and selection of information necessary for the development of activities. Expand or rethink existing knowledge and/or professional practice within a specific field or at the intersection of fields. Demonstrate the ability of sustained interest in developing new ideas or processes and a high level of understanding of learning processes. Methodological knowledge in the field of innovation and professional activity
Duration of training:	3 years
Volume of loans:	180

Almaty 2024

The educational program «8D07201 - Mineral processing» was approved at the meeting of K.I. Satbayev KazNRTU Academic Council

Protocol No. 12 dated «22» 04 2024.

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

Protocol No. 6 dated «19» 04 2024.

Educational program «8D07201 - Mineral processing» was developed by Academic committee based on direction of «Manufacturing and processing industries»

Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairperson of Academic Committee:				
Barmenshinova M.B.	c.t.s., associate professor	Head of the Department of MaMP	KazNRTU named after K.I.Satpaeva	
Teaching staff:				
Shautenov M.R.	c.t.s., docent	Professor of the Department of MaMP	KazNRTU named after K.I.Satpaeva	
Telkov Sh.A.	c.t.s., docent	Professor of the Department of MaMP	KazNRTU named after K.I.Satpaeva	
Employers:				
Dzhetybaeva U.K.	c.t.s.	Main enrichment	«Kaz Minerals» LLP	
Students				

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List of abbreviations and symbols

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

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

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

EP - educational program;

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

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

WC - working curriculum;

CED - catalog of elective disciplines;

UC - university component;

CC - component of choice;

NQF - National Qualifications Framework;

SQF - Sectoral Qualifications Framework;

LO - learning outcomes;

KC - key competencies;

SDG - Sustainable Development Goals.

1. Description of the educational program

The educational program for the preparation of a Doctor of Philosophy (PhD) has a scientific and pedagogical orientation and assumes fundamental educational, methodological and research training and in-depth study of disciplines in the relevant fields of sciences for the system of higher and postgraduate education and the scientific sphere.

The educational program for the preparation of a doctor in the profile involves fundamental educational, methodological and research training and in-depth study of disciplines in the relevant areas of science for the branches of the national economy, social sphere: education, medicine, law, art, economics, business administration and in the field of national security and military affairs.

The educational programs of doctoral studies in terms of professional training are developed on the basis of studying the experience of foreign universities and research centers that implement accredited programs for the preparation of PhD doctors or doctors in the profile.

The content of the educational program of the profile doctoral program is determined by the university independently.

The main criterion for the completion of the educational process for the preparation of doctors of philosophy (PhD) (doctors in the profile) is the development of at least 180 academic credits by a doctoral student, including all types of educational and scientific activities.

The duration of doctoral studies is determined by the amount of academic credits mastered. Upon mastering the established amount of academic credits and achieving the expected learning outcomes for obtaining a Doctor of Philosophy (PhD) degree or by profile, the educational program of the doctoral program is considered fully mastered.

The training of personnel in doctoral studies is carried out on the basis of master's degree educational programs in two directions:

1) scientific and pedagogical with a training period of at least 2 years;

2) profile with a training period of at least 1 year.

The content of the doctoral program consists of:

1) theoretical training, including the study of cycles of basic and core disciplines;

2) practical training of doctoral students: various types of practices, scientific or professional internships;

3) research work, including the execution and defense of a PhD dissertation;

4) final certification.

The educational program includes the following stages of doctoral students' preparation: research methods, academic writing, current trends in the development of the theory and technology of enrichment production, theory and technology of selective disintegration of mineral raw materials, methods for optimizing design solutions of mining and processing complexes, conditioning of circulating and wastewater treatment of enrichment production, theory and technology of

biogydrometallurgical processing of hard-to-enrich raw materials, nanotechnology mineral and non-traditional raw materials.

The ability to choose disciplines from the catalog of elective disciplines of Satbayev University.

Types of research activities: conducting experimental studies of processes, aggregates and products; application of methods of planning experiments and statistical data processing; application of methods of mathematical modeling of processes; performing literary and patent search, preparation of reports, reviews, conclusions, participation in the implementation of technological processes for obtaining conditioned concentrates; develops technological processes for obtaining enrichment products from raw materials; calculates the main and selects auxiliary equipment, develops and researches mathematical models of enrichment processes.

Objects of professional activity.

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

2. The purpose and objectives of the educational program

The purpose of EP «8D07201 – mineral processing»:

– training of highly qualified specialists with core competencies in solving organizational and production tasks in the implementation of innovative projects in the field of mineral and man-made raw materials enrichment; formation of personnel for the innovative economy of mineral processing, covering modern energy-saving technologies, design activities, innovative solutions, entrepreneurship in the high-tech sector, the introduction of innovative technologies for processing mineral raw materials, reducing the anthropogenic impact on the environment and participation in international scientific research.

The objectives of the EP «8D07201 – mineral processing» are:

- training of professionals in analytical, consulting and research activities;
- independent conduct of research, R&D, any project activity in the field of enrichment; compliance with international engineering qualifications;
- training of specialists for the implementation of pedagogical activities in universities in the profile;
- retraining and advanced training of specialists and managers;
- the graduate must master the basic laws of economic development; factors affecting the technical and economic efficiency of production; knowledge of sociology and psychology in the management of the enterprise; the ability to qualitatively and quantitatively substantiate management decisions.
- assessment of innovation and technological risks in the introduction of new technologies;
- creation of methods to reduce the environmental impact of enrichment processes, including reducing emissions and reducing water and energy consumption;
- competence in the marketing of high-tech technologies;
- development of personal scientific and metric indicators of graduates;
- foreign internship.

3. Requirements for evaluating the learning outcomes of an educational program

A doctoral student should 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;

to 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;
- to realize and accept the social responsibility of science and education;
- perfect foreign language for scientific communication and international cooperation;

be able to:

- to organize, plan and implement the process of scientific research;
- analyze, evaluate and compare various theoretical concepts in the field of research and draw conclusions;
- analyze and process information from various sources;
- 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;

have skills:

- critical analysis, evaluation and comparison of various scientific theories and ideas;
- analytical and experimental scientific activities;
- planning and forecasting of research results;
- public speaking and public speaking at international scientific forums, conferences and seminars;
- scientific writing and scientific communication;
- planning, coordination and implementation of scientific research processes;
- a systematic understanding of the field of study and demonstrate the quality and effectiveness of the selected scientific methods;

- participation in scientific events, fundamental scientific domestic and international projects;
- leadership management and team management;
- responsible and creative attitude to scientific and scientific-pedagogical activity;
- conducting patent search and experience in the transfer of scientific information using modern information and innovative technologies;
- protection of intellectual property rights to scientific discoveries and developments;
-free communication in a foreign language;

be competent:

- in the field of scientific and scientific-pedagogical activity in the conditions of rapid updating and growth of information flows;
- in carrying out theoretical and experimental scientific research;
- in the formulation and solution of 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 the examination of scientific projects and research;
-in ensuring continuous professional *growth.*

4. Passport of the educational program

4.1. General information

№	Field name	Note
1	Code and classification of the field of education	8D07 - Engineering, manufacturing and construction industries
2	Code and classification of training areas	8D072 - Manufacturing and processing industries
3	Group of educational programs	D118 – Mineral processing
4	Name of the educational program	Mineral processing
5	Brief description of the educational program	The educational program for the preparation of a Doctor of Philosophy (PhD) has a scientific and pedagogical orientation and assumes fundamental educational, methodological and research training and in-depth study of disciplines in the relevant fields of sciences for the system of higher and postgraduate education and the scientific sphere.
6	Goal EP	training of highly qualified specialists with core competencies in the field of solving organizational and production tasks in the implementation of innovative projects in the field of mineral and man-made raw materials enrichment; formation of personnel for the innovative economy of mineral enrichment, covering modern energy-saving technologies, project activities, innovative solutions, entrepreneurship in the high-tech sphere.
7	View EP	New
8	The level of the NQF	Level 8 – Postgraduate education (programs leading to the academic degree of Doctor of Philosophy (PhD) and doctors in the profile and/or practical experience)
9	Software level ORC	Level 8 – Knowledge at the most advanced level in the field of science and professional activity. Use specialized knowledge for critical analysis, evaluation and synthesis of new complex ideas that are at the cutting edge of this field. Evaluation and selection of information necessary for the development of activities. Expand or rethink existing knowledge and/or professional practice within a specific field or at the intersection of fields. Demonstrate the ability of sustained interest in developing new ideas or processes and a high level of understanding of learning processes. Methodological knowledge in the field of innovation and professional activity
10	Distinctive features of the EP	no
11	List of competencies of the educational program:	Professional competencies; Research competencies; Basic competencies and knowledge; Communication competencies; Universal competencies; Management competencies; Cognitive competencies; Creative competencies;

		Information and communication competencies.
12	Learning outcomes of the educational program:	RO1 - Are able to apply advanced knowledge in the field of processing of mineral and man-made raw materials based on various enrichment methods in their professional activities, to introduce mineral processing technologies using digital and automated solutions PO2 - the ability to master methodological techniques and teaching skills in the field of mineral processing. RO3 - capable of conducting independent original scientific research that contributes to the development of the mining and processing industry. PO4 - the ability to apply research skills in order to present and interpret the results of scientific research. RO5- capable of conducting independent research that contributes to the development of the mining and processing industry, in accordance with the best practices and standards of the processing industry. They are able to develop new theoretical and experimental approaches to waste reduction and disposal of enrichment tailings. RO6 - Are able to demonstrate high professional research and cognitive skills in the preparation and defense of a doctoral dissertation
13	Form of training	Full - time full
14	Duration of training	3 years
15	Volume of loans	180
16	Languages of instruction	Kazakh/Russian
17	Academic degree awarded	Doctor of PhD
18	Developer(s) and authors:	Barmenshinova M.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
Cycle of basic disciplines University component									
1	Methods of scientific research	The course contributes to the formation of knowledge about the methods, methodology of scientific research, methods of collecting and processing scientific data, the principles of the organization of scientific research, the role of technical sciences, computer science and engineering research in modern science. The structure of technical sciences, the application of general scientific, philosophical, special methods of scientific research in theory and in practice are considered.	5		V	V	V		
2	Academic writing	The course is aimed at developing academic writing skills and writing strategies for doctoral students in the field of engineering and natural sciences. The course focuses on the basics and general principles of academic writing for; writing effective sentences and paragraphs; using tenses in scientific literature, as well as styles and punctuation; writing abstracts, introductions, conclusions, discussions, conclusions, literature and resources used; quoting in the text; preventing plagiarism, and making presentations at a conference.	5	V	V	V			
Cycle of basic disciplines Elective component									
3	Current trends in the development of the theory and technology of enrichment production	The current state and trends in the development of the raw material base of metal production. Modern trends in the development of enrichment processes and enrichment engineering. Familiarization with the best samples of processing equipment of foreign companies, with new technological schemes of the processes of enrichment of ore and man-made raw materials containing gold, non-ferrous and ferrous, rare and rare earth metals. Analysis of the principles and patterns of the main processes in the enrichment of minerals with the use of new reagents, methods of analysis and methods of research.	5		V	V	V		
4	Theory and technology of selective disintegration of mineral raw materials	Basic concepts of the disintegration of heterogeneous materials. Models of the origin and growth of cracks. Energy aspects of destruction models. Uncontrolled and controlled factors of ore destruction. Methods and devices for studying the strength characteristics of ores and minerals. Dislocation structure of minerals and accretion boundaries. Comparison of particle strength and the spectrum of force effects in a mill. Disintegration of technogenic materials. Analysis of the causes of high energy consumption in grinding processes. Selective softening by physical influences. Destruction by thermal stresses and on the basis of wave processes (Snyder and Dean-Gross technologies, explosive rebounding), technologies of exposure to electric fields, spontaneous disintegration of ores when exposed to surfactants. Principles of disintegration modeling. Analysis of the work of crushers and mills from the standpoint	5			V	V	V	

		of selective destruction.							
5	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. 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.	5			V	V	V	
Cycle of profile disciplines Component of choice									
6	Methods of optimization of design solutions of mining and processing complexes	Formalization of the task of making design decisions. An example of a decision-making model under uncertainty. Structure and formulation of optimization problems. Optimality conditions and types of computational optimization procedures. One-dimensional optimization methods (Golden Section method, Step-by-step method). Methods for finding the extremum of functions of many variables (Gradient and gradient-free methods). Conditional optimization methods (Method of penalty functions; Method of direct search with return; Method of possible directions; Search for the extremum of functions of many variables in the presence of connections). Linear programming problems. Variational problems and methods of their solution. Multi-criteria selection. Translating criteria into constraints. Weighting and combining criteria (Method of weighted sum of partial criteria; Multiplicative criterion; Methods for determining weighting coefficients). Methods of sequential optimization (The method of sequential concessions. The method of equality of particular criteria). A method for analyzing hierarchies. Pareto optimality (Pareto set construction methods. Ways to narrow the Pareto set) Decision-making in conditions of risk and uncertainty (Building a "decision tree" and an outcome table; the "utility" function; Decision-making in conditions of uncertainty). Features of project decision-making. Basic concepts and methods of making a project decision.	5			V	V	V	V
7	Conditioning of circulating and wastewater treatment of processing production	The composition of wastewater from processing plants. Mechanical wastewater treatment. Neutralization. Wastewater treatment from metal cations, arsenic and antimony, xanthogenates and dithiophosphates, cyanides and rhodanides, sulfides, phenols and cresols, from petroleum products. Coagulation and flocculation. Extraction wastewater treatment. Sorption wastewater treatment. Ion exchange wastewater treatment. Flotation wastewater treatment. Biotechnological methods of purification of industrial wastewater, soils from heavy non-ferrous metal ions with the disposal of industrial waste. Electrochemical methods and devices for neutralization and conditioning of cyanide-containing industrial solutions of MMC enterprises. Automatic control and management of the operation of treatment facilities and tailings dumps of mining and metallurgical enterprises. Methods of biotesting in the environmental monitoring system of mining and metallurgical enterprises. Disinfection of wastewater. Natural wastewater treatment in tailings dumps. Circulating water supply of processing	5		V	V	V	V	

		plants. Concentration of reagents in recycled water. Conditioning of circulating water. Selection of the wastewater treatment scheme. Wastewater treatment schemes. The system of rationing of water consumption and sanitation is an important aspect of environmental protection. Mountain ecology and its impact on the environment. Assessment of the impact of the mining and metallurgical complex on the environment. Development of certification of the environmental management system at industrial enterprises.							
8	Theory and technologies of hydrometallurgical processing of difficult-to-enrich raw materials	The current state of hydrometallurgical processes and equipment. Theoretical foundations and technologies for the use of microorganisms in the leaching of metals, schemes for processing concentrates. The use of microorganisms for wastewater treatment, the experience of domestic and foreign enterprises. Trends in the development of biohydrometallurgy of processing metals from uranium-containing, gold-containing and polymetallic ores, in the production of materials with increased added value, including the production of nanoscale materials. Economic and environmental aspects of the application of biohydrometallurgical processing of difficult-to-enrich raw materials.	5				V	V	V
9	Nanotechnologies of mineral and non-traditional raw materials	Physico-chemical fundamentals of nanotechnology. Dimensional effect of different nature and ways of their practical use in various nanostructures and products. Modern methods of obtaining, researching and determining the properties of nanomaterials. The main directions of development of nanotechnology and nanotechnology: physical nanomaterial science and nanomechanics, nanoelectronics and nanobiotechnology. Examples of specific developments brought to industrial production. Modern concepts of electrical, magnetic, thermal, optical, diffusion, chemical and mechanical properties of nanomaterials. The dependence of these properties on the structure of the material and the geometric dimensions of the nanoparticles. Issues of storage and transportation of nanomaterials. For the first time in the course, liquid systems containing nanostructured components and nanoprocesses occurring in it, manifested in flotation systems, are considered. Nanoassociates and nanodispersions of flotation systems are systematized. The influence of physicochemical and structural changes in interphase nanoassociates on the flotation properties of flotation system components is given.	5			V	V	V	

5. Curriculum of the educational program

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

SATBAYEV UNIVERSITY

APPROVED
Chairman of the Management Board-
Rector of Kazatu named after K.Satpayev
M.M. Begentnev
"22" 04 2024 y.

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

Educational program 8D07201 - "Mineral processing"
Group of educational programs D118 - "Mineral processing"

Form of study: full-time | Duration of study: 3 year | Academic degree: Doctor of Philosophy PhD

Discipline code	Name of disciplines	Cycle	Total volume in academic classes	Total amount in academic 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		3 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	3	5	150	2/0/1	105	E	5					
LNG305	Academic writing	BD UC	3	5	150	0/0/3	105	E	5					
component of choice														
MET319	Modern trends in the development of the theory and technology of enrichment production	BD CCH	3	5	150	2/0/1	105	E	5					
MET320	Theory and technology of selective disintegration of mineral raw materials													
MNG349	Intellectual property and the global market													
CYCLE OF PROFILE DISCIPLINES (PD)														
M-2. Module of professional activity (component of choice)														
MET317	Methods of optimization of design solutions of mining and processing complexes	PD, CCH	3	5	150	2/0/1	105	E	5					
MET316	Air conditioning recycling and wastewater treatment and mineral processing													
MET318	Theory and technology of biohydrometallurgical processing of refractory raw materials	PD, CCH	3	5	150	2/0/1	105	E	5					
MET315	Nanotechnology of mineral and non-traditional raw materials													
M-3. Practice-oriented module														
AAP350	Pedagogical practice	BD UC	10	10						10				
AAP355	Research practice	PD UC	10	10							10			
M-4. Experimental research module														
AAP336	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	5	5					5					
AAP347	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	40	40						20	20			
AAP356	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	60	60								30	30	
AAP348	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	18	18										18
M-5. Module of final attestation														
ECA303	Writing and defending a doctoral dissertation	FA	12	12										12
	Total based on UNIVERSITY:								30	30	30	30	30	30

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	5	25
PD	Cycle of profile disciplines		10	10	20
	Total for theoretical training:	*0*	*30*	*15*	*45*
	RWDS	123			123
FA	Final attestation	12			12
	TOTAL:	135	30	15	180

Decision of the Academic Council of KazNRTU named after K.Satpayev. Protocol № 12 от "22" 04 2024 y.

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Protocol № 6 от "19" 04 2024 y.

Decision of the Academic Council of MaMI named after O. Baikonurov. Protocol № 7 от "27" 03 2024 y.

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

Director of the Mining and Metallurgical Institute named after O. A. Baikonurov — K.B. Rysbekov

Head of department "Metallurgy and mineral processing" — M.B. Barmenshinova

Representative of the employers' council of the LLP "KAZ Minerals" — U.K. Jetybaeva