Mining and Metallurgical Institute named after O.A. Baikonurov

Department of "Materials Science, Nanotechnology and Engineering Physics"

EDUCATIONAL PROGRAM

8D07114 Nanomaterials and Nanotechnology

Code and classification of the field of education: **8D07"Engineering, manufacturing and construction industries"**

Code and classification of training directions:

8D071 "Engineering and Engineering Trades"

Group of educational programs:

D108 Nanomaterials and nanotechnologies

Level based on NQF: 8
Level based on IQF: **8**
Study period: 3 years
Amount of credits: **180**

Almaty 2024

The educational program 8D07114 Nanomaterials and Nanotechnology was approved at a meeting of the Academic Council of KazNTU named after K.I.Satpayev.

Protocol No. 12, «22» 04. 2024

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

Protocol No. 6, «19» 04. 2024.

Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairman of the Academic Committee:				
Mutushev A.	PhD	General Director	Scientific Production and Technical Center "ZHALYN"	
Academic committee members:				
Kudaibergenov K.	PhD	Head of Department	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev"	
Smagulov D.	Doctor of Technical Sciences	Professor	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev"	
Nazhipkyzy M.	PhD in Chemistry	Associate Professor	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev"	
Kemelbekova A.	PhD in material science	Teacher	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev»	
Yetish T.	PhD student	Assistant	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev»	
Abay A.		Student	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev»	

Table of contents

List of abbreviations and designations

Abbreviation		Full name
Ts	–	Teaching staff
EP	–	Educational program
OR	–	Registrar's Office
WC	–	Working Curriculum EP

1. Description of educational program

The educational program 8D07114 "Nanomaterials and nanotechnology" is the third level of qualification of the three-level higher education system.

The program is aimed at training specialists in a wide range of activities. The necessary basic knowledge and skills in the field of training highly qualified scientific and scientific-pedagogical personnel capable of: conducting fundamental, applied and innovative research in the field of obtaining nanomaterials and nanotechnology; developing new directions of nanomaterials and nanotechnology in the field of physics, chemistry, biology and medicine; commercializing the results of research and nanotechnology, experimental design work.

Graduates, having received the degree of "Doctor of PhD in the educational program 8D07114 "Nanomaterials and nanotechnology", have the following opportunities:

1. To develop methods for obtaining nanostructured and semiconductor materials based on plasma technologies and chemical synthesis;
2. To conduct experimental studies using X-ray diffraction analysis, optical microscopy and electrical research methods to obtain a description of the characteristics of nanomaterials;
3. Conducts theoretical assessments of the characteristics of nanomaterials using computer and numerical modeling methods;
4. To lead design and engineering works aimed at creating new electronic devices, circuits and devices for various functional purposes based on nanomaterials;
5. Commercialization of research and development results through participation in competitions;
6. Improves the properties of nanocomposite materials and medicines using modern plasma technologies and nanotechnology, including bionanotechnology;
7. Organizes research activities in the field of nanomaterials, bio- and nanotechnology, using new methods of analysis and production technologies, taking into account economic and environmental efficiency;
8. Development of scientific and methodological manuals based on the results of scientific research in the field of bio/nanotechnology and nanomaterials for their implementation in the educational process;
9. Analyzes and evaluates the results of innovative activities, modern theories, problems and approaches, new trends in the development of innovative nanomaterials;
10. To maintain and diagnose scientific and technical equipment in the field of bio/nanotechnology and nanomaterials, to make recommendations on improving the parameters and characteristics of the measuring system;

2. Purpose and objectives of educational program

The purpose of the EP:

The program is aimed at training scientific and scientific-pedagogical personnel capable of: conducting fundamental, applied and innovative research in the field of nanostructure synthesis; developing new directions of nanomaterials and nanotechnology in the field of physics, chemistry, biology and medicine; commercializing the results of research and development activities.

Tasks of the EP:

1) knowledge and understanding of the scientific and mathematical principles underlying various specializations in engineering physics and materials science;

2) the ability to apply the acquired knowledge to the formulation, formulation and solution of applied scientific problems in technical physics using recognized methods;

3) the ability to apply the acquired knowledge to the analysis of technical systems, processes and methods related to various specializations in engineering physics and materials science, including using modeling methods;

4) understanding of engineering systems design methodologies and the ability to apply them;

5) the ability to find the necessary literature, use databases and other sources of information;

6) the ability to analyze, plan and conduct the necessary research, interpret the data obtained and draw conclusions;

7) The ability to select and use appropriate equipment, tools and techniques;

8) Work effectively both individually and as a team member;

9) show awareness in the field of project management and business, knowledge and understanding of the impact of risks and changing conditions;

10) be aware of the need and have the ability to independently study and improve their skills throughout their lives;

11) understanding of health, safety, legal aspects and responsibility for engineering activities, understanding the impact of engineering solutions on the social context and the environment:

12) follow the code of professional ethics and standards of engineering practice.

3. Requirements for evaluating the educational program learning outcomes

Learning outcomes include knowledge, skills and competencies and are defined both for the educational program as a whole and for its individual modules, disciplines or assignments.

The main task at this stage is to select assessment methods and tools for all types of control, with the help of which it is possible to most effectively assess the achievement of planned learning outcomes at the discipline level.

4. Passport of educational program

4.1. General information

№	Field name	Comments
1	Code and classification of the field of education	8D07 "Engineering, processing and construction industries"
2	Code and classification of training directions	"8D071 " Engineering and Engineering"
3	Educational program group	D108 "Nanomaterials and nanotechnology"
4	Educational program name	8D07114 "Nanomaterials and Nanotechnology"
5	Short description of educational program	Educational program 8D07114 "Nanomaterials and Nanotechnology" is the last qualification level of the three-level higher education system
6	Purpose of EP	The program is aimed at training scientific and scientific-pedagogical personnel capable of: conducting fundamental, applied and innovative research in the field of nanostructure synthesis; developing new directions of nanomaterials and nanotechnology in the field of physics, chemistry, biology and medicine; commercializing the results of research and development activities.
7	Type of EP	New EP
8	The level based on NQF	8
9	The level based on IQF	8
10	Distinctive features of EP	No
11	List of competencies of educational program	KK1. Communicativeness KK2. Basic literacy in Natural science disciplines KK3. General engineering competences KK4.Professional competencies KK5. Engineering-computer competencies KK6.Engineering-working competencies KK7. Socio-economic competences KK8. Special-professional competences
12	Learning outcomes of educational program	LO1 to substantiate the choice of experimental methods for studying systems with micro- and nano-sizes;

		LO2 plan the organization and conduct of an experiment to obtain materials with special physical and chemical properties (porous nanostructures, magnetic nanomaterials, nanobiomaterials); LO 3 Integrate knowledge in professional activities and have the competence to argue their ideas when making decisions in the field of engineering and technology; LO 4 explain the specifics of the functional purpose of equipment in the field of materials science and the possibility of its digitalization; LO 5 apply physical and chemical methods for obtaining nano-objects and their composites for solving applied problems, as well as methods for describing structures, structures, composition, morphologies; LO 6 to study the current trends in advanced materials science for further scientific and pedagogical activities; LO 7 choose the best methods for solving the problems of materials science, nanoproduction, processing and modification of materials; LO 8 to model and evaluate the forecast of product quality by the parameters of the technological process in order to optimize it in accordance with the type of product obtained;; LO 9 investigate the structure of the material by conducting a physical experiment using laboratory equipment and modern scientific equipment;
13	Education form	Full - time
14	Period of training	3
15	Amount of credits	180
16	Languages of instruction	Kazakh, Russian
17	Academic degree awarded	PhD
18	Developer(s) and authors	Mutushev A. Kudaibergenov K. Smagulov D. Nazhipkyzy M. Kemelbekova A. Yetish T. Abay A

4.2. Relationship between the achievability of the formed learning outcomes based on educational program and academic disciplines

№	Discipline name	Short description of discipline	Amount of credits	Generated learning outcomes (codes)							
				PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
Cycle of general education disciplines University component											
1	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		
2	Research methods	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**	
Cycle of basic disciplines Component of choice											

3	Advanced structural technology hardening	The course content includes modern methods of materials research; classification of structural levels of solids, dimensional and morphological characteristics of granular, cellular and modulated and atomic and molecular structures. The features of real structures, stochasticity and the probability of evolution of complex systems are considered, the irreversibility, non-equilibrium, nonlinearity and unpredictability of processes in open systems, the autowave nature of material objects and processes, fractality and self-organization of structures of different levels under external influences are studied.	5	**v**			**v**				
4	Physics and technique of saving and renewable energy	Discipline is devoted to the description and analysis of renewable energy sources, their use in the overall energy balance of the country and regions. Discipline also covers the issues of world energy conservation in industry, agriculture and housing and communal facilities. The use of secondary energy resources and the improvement of environmental conditions are also being considered; technical and economic indicators of the use of renewable energy in agriculture; application of resource-saving technologies using renewable energy.	5	**v**					**v**		
5	Computer simulation of engineering tasks	The discipline studies the construction of a mathematical model that describes the process under study and numerical methods of calculation. The creation of a program that implements a computational algorithm that calculates and processes the information received is considered. The analysis of the results of calculations is also studied in comparison with a full-scale experiment.	5		**v**					**v**	
6	Semiconductor heterostructures and devices based on them	The discipline studies a multilayer structure of semiconductors with different bandgap widths of	5				**v**				**v**

		several microns. Materials are considered that have the same crystal structure, where charge carriers move freely through the layer boundaries. Such a concept as a heterojunction and related devices based on this phenomenon are being studied.									
7	Software for structuring materials	The course covers the basic concepts of structuring materials using software, as well as the use of analytical equipment and instruments. The discipline is a complex for the study of modern research methods and the use of materials. An overview of the current state of the software for the structure formation of materials is given. The course examines the processes in the field of theory and practice using modern software.	5					v			
8	Physicochemical methods of materials research	When studying the discipline, doctoral students will study the following aspects: the principles of studying the chemical composition and structure of matter through the use of physical methods of analysis, including atomic spectroscopy, optical spectroscopy, magnetic resonance spectroscopy, mass spectroscopy, IR spectroscopy.	5							v	

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

SATBAYEV UNIVERSITY

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

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

Educational program 8D07114 - "Nanomaterials and Nanotechnology"
Group of educational programs D108 - "Nanomaterials and Nanotechnology"

Form of study: full-time **Duration of study: 3 year** **Academic degree: Philosophy Doctor (PhD)**

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	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													
PHY316	Advanced structural technology hardening	BD CCH	5	150	2/0/1	105	E	5					
PHY319	Physics and technique of saving and renewable energy				2/0/1								
MNG350	Sustainability Science				2/0/1								
CYCLE OF PROFILE DISCIPLINES (PD)													
M-2. Module of professional activity (component of choice)													
PHY302	Physicochemical methods of materials research	PD CCH	5	150	2/0/1	105	E	5					
PHY320	Semiconductor heterostructures and devices based on them				2/0/1								
PHY318	Software for structuring materials	PD CCH	5	150	2/0/1	105	E	5					
PHY321	Computer simulation of engineering tasks				2/0/1								
M-3. Practice-oriented module													
AAP350	Pedagogical practice	BD UC	10						10				
AAP355	Research practice	PD UC	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					
AAP347	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	40						20	20			
AAP356	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS UC	60								30	30	
AAP348	Research work of a doctoral candidate, including internships and completion of a doctoral dissertation	RWDS 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		20	5	25
PD	Cycle of profile disciplines		10	10	20
	Total for theoretical training:	*0*	*30*	*15*	*45*
	RWDS				*123*
FA	Final attestation	12			12
	TOTAL:	12	30	15	180

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

Decision of the Educational and Methodological Council of Kazntu named after K.Satpayev. Protocol № 8 от "19" 04 2024 y.

Decision of the Academic Council of the Institute_____. Protocol № 7 от "29" 03 2024 y.

Vice-Rector for Academic Affairs Uskenbayeva R.K.

Director of M&M Institute Rysbekov K.B.

Head of the MN&EP Department Kudaibegenov K.K.

Specialty Council representative from employers Idrisova T.K.