Mining and Metallurgical Institute named after O.A. Baikonurov
Department of "Materials Science, Nanotechnology and Engineering Physics"

EDUCATIONAL PROGRAM
7M05301 «Applied and engineering physics»

Code and classification of the field of education:
7M05 Natural Sciences, Mathematics and Statistics
Code and classification of training directions:
7M053 Physical and chemical sciences
Group of educational programs:
M090 Physics
Level based on NQF:7
Level based on IQF:7
Study period: 2 years
Amount of credits:120

Almaty 2025

Educational program 7M05301 «Applied and engineering physics» was approved at the meeting of K.I. Satbayev KazNRTU Academic Council
Minutes # 10 dated «06» 03 2025.
was reviewed and recommended for approval at the meeting of K.I. Satbayev KazNRTU Educational and Methodological Council
Minutes # 3 dated «20» 12 2025 .
Educational program 7M05301 «Applied and engineering physics» was developed by Academic committee based on direction 7M053 Physical and chemical sciences

Full name	Academic degree/ academic title	Position	Workplace	Signature
Chairperson of Academic Committee:				
Kakimov U.K.	PhD	Head of Department	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev"	
Teaching staff:				
Azat S.	PhD	Professor	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev"	
Kudaibergenov K.	PhD	Associate Professor	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev"	
Kemelbekova A.	PhD in material science	Senior Lecturer	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev»	
Yetish T.	Master of technical science, PhD student	Lecturer	Non-profit Joint Stock Company "Kazakh National Research Technical University named after K.I. Satpayev»	
Employers:				
Mutushev A.	PhD	General Director	Scientific Production and Technical Center "ZHALYN"	
Students				
Lihanov S.		2rd year student	Non-profit Joint Stock	

			Company “Kazakh National Research Technical University named after K.I. Satpayev»	
Altynov Y.		2nd year student	Non-profit Joint Stock Company “Kazakh National Research Technical University named after K.I. Satpayev»	
Serikkyzy A.		2nd year student	Non-profit Joint Stock Company “Kazakh National Research Technical University named after K.I. Satpayev»	

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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

Educational program 7M05301 - “Applied and engineering physics” - is the second level of qualification of the three-level higher education system, which lays the basis for the subsequent doctoral program.

The program is aimed at training specialists in a wide range of activities. The necessary basic knowledge and skills in the field of natural sciences, engineering and technology will allow future specialists to easily integrate into the work process of almost any industry, research institutes, and universities. The educational program lays the scientific foundations in the field of materials science, nanotechnology, nuclear technology, computer technology, and semiconductor electronics. Specialist training is conducted in the field of research, development, creation and operation of new materials, technologies, instruments and devices. The work of specialists consists of manufacturing, improving, operating and repairing instruments and devices, creating and researching new materials, as well as their development and implementation of technologies in the areas of application.

Graduates, having received the degree “Master of Technical Sciences in the educational program 7M05301 - “Applied and engineering physics”, have the following opportunities:

-analyze the state of a scientific and technical problem, formulate technical specifications, set goals and objectives of research based on the selection and study of literary and patent sources;

-select optimal methods and research programs, modify existing ones and develop a new method based on the problem of a particular study;

-conduct theoretical and experimental research with the aim of modernizing or creating new materials, components, processes and methods;

-model physico-mathematical and physico-chemical modeling of developed materials, parts and processes in order to optimize their parameters;

-use of standard and development of new software products aimed at solving scientific, design and technological problems within the framework of professional activities.

Implies: engineer-physicist in all branches of production; engineering researcher in design organizations, institutions, institutes, universities; teaching staff member; technical specialist, technical consultant in areas of activity; technical engineer, process engineer in the field of materials science (materials scientist, copper); research engineer; electronics engineer, etc.

2. Purpose and objectives of educational program

Purpose of EP:

Training of scientific, scientific-pedagogical and engineering personnel of a physical and technical profile for science, education and industry with the skills of a working group leader and an expert to solve applied problems focused on the development and implementation of innovative technologies using computer simulation to integrate scientific research into industrial enterprises.

Tasks of EP:

1) Knowledge and understanding of scientific and mathematical transformations based on various specializations in engineering physics and materials science;

2) The ability to apply acquired knowledge to set, formulate and solve applied scientific problems in technical physics, using recognized methods;

3) The ability to apply acquired knowledge to analyze 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) Ability to select and use suitable equipment, tools and methods;

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

9) Demonstrate awareness in the field of project management and business, knowledge and understanding on the part of the supplier and changing conditions;

10) Recognize the need and have the opportunity to independently study and improve qualifications throughout life;

11) Understanding of health, safety, legal issues and responsibilities in engineering, understanding engineering decisions in social and environmental contexts;

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 determined both for the educational program as a whole and for its individual modules, disciplines or assignments.

Selecting means of assessing learning outcomes The main task at this stage is to select assessment methods and tools for all types of control, with the help of which one can 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	7M05 Natural Sciences, Mathematics and Statistics
2	Code and classification of training directions	7M053 Physical and chemical sciences
3	Educational program group	M090 Physics
4	Educational program name	7M05301– «Applied and engineering physics»
5	Short description of educational program	Educational program 7M05301 – “Applied and Engineering Physics” is the second level of qualification of the three-level higher education system
6	Purpose of EP	Training of scientific, scientific-pedagogical and engineering personnel of a physical and technical profile for science, education and industry with the skills of a working group leader and an expert to solve applied problems focused on the development and implementation of innovative technologies using computer simulation to integrate scientific research into industrial enterprises.
7	Type of EP	New EP
8	The level based on NQF	7
9	The level based on IQF	7
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	1) Assess the opportunities and conditions for commercialization to develop an enterprise strategy in the field of engineering physics, computer simulation of physical processes and "green energy" on digital platforms when

		enterprises move to an innovative technological level 2) integrate scientific and professional knowledge and foreign experience into the practice of the educational process in higher education in production and management, design and construction, organisational and technological and scientific and pedagogical areas 3) Organise the work of teams of performers on adjustment of technological equipment of high complexity using the necessary methods and means of analysis 4) To systematize further education in the field of industrial production, technological engineering, scientific and innovative activities 5) To plan activities for the development of innovative projects using the principles and methods of organizing and managing production with the integrated use of elements of the system for diagnosing available resources 6) Formulate at a professional level their knowledge, understanding and ability to solve problems in a new environment, in a broader interdisciplinary context 7) Explore the theoretical aspects of applied physics to improve the pedagogical skills of the graduate 8) To formulate system knowledge for independent research work on the creation, research and application of low-dimensional structures in the field of applied physics
13	Education form	Full - time
14	Period of training	2 years
15	Amount of credits	120
16	Languages of instruction	Russian, Kazakh
17	Academic degree awarded	Master
18	Developer(s) and authors	Mutushev Alibek Zhumabekovich Kakimov Ulan Kadyrkhanuly Azat Seythan Kudaibergenov Kenes Kakimovich Kemelbekova Ainagul Erzhanovna Yetish Talshyn Erbolkyzy

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 basic disciplines University component											
1	Foreign language (professional)	The purpose of the course is to improve and develop foreign language communication skills in the professional and academic field. Course content: 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).	3	✓	✓			✓			
2	History and philosophy of science	Purpose: To explore the history and philosophy of science as a system of concepts of global and Kazakh science. Contents: The subject of philosophy of science, dynamics of science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy	3		✓				✓		

		of mathematics, physics, engineering and technology, specifics of engineering sciences, ethics of science, social and moral responsibility of a scientist and engineer.									
3	Higher school pedagogy	Purpose: To learn how to solve scientific and pedagogical problems, taking into account new technologies in the field of higher education. Contents: methodological and theoretical foundations of higher school pedagogy, modern pedagogical technologies, planning and organization of learning and upbringing processes, the use of communicative technologies of subject-subject interaction between a teacher and a student in the educational process of a university, human resource management in higher educational institutions.	3	✓	✓			✓			
4	Psychology of management	Objective: To acquire skills in making strategic and managerial decisions, taking into account the psychological characteristics of the individual and the team. Content: the modern role and	3		✓				✓		

		content of psychological aspects in management activities, methods for improving psychological literacy, the composition and structure of management activities, both at the local and foreign levels, the psychological feature of modern managers.									
Cycle of basic disciplines Elective component											
5	Intellectual property and research	Purpose: to train specialists who can effectively manage rights to the results of intellectual activity in the field of science, as well as ensure their legal protection and commercialization. Content: analysis of legal protection of research and development results, methods of commercialization of scientific inventions, ethical and legal aspects of scientific activity in the context of IP.	5		✓			✓	✓		
6	Information technologies in science and production	The discipline studies the basics of information technologies, their role in solving applied problems, purpose, composition, structure, types and technologies of using information systems and technologies, their elements, the order of functioning, classification features. In addition, special attention is	5	✓		✓	✓				

		paid to specialized software tools, the development of new technologies of production processes, the improvement of information technologies in the management of these processes.									
7	Materials science and advanced materials technology	The discipline is aimed at studying the basic provisions and principles of the formation of a given level of structure and properties of materials for various purposes, mastering the principles of managing the structural-phase state of materials and the influence of technological factors of external influence on it, modern aspects of the use of specific practical techniques for the implementation of new materials with specified properties.	5	✓		✓			✓		✓
8	Synthesis Methods of Nanomaterials and Nanostructures	The discipline studies methods for obtaining nanostructures and functional nanomaterials with certain specified properties. Methods of controlled growth for the synthesis of nanostructures of the required size and shape, methods for the synthesis of films and coatings,	5	✓		✓		✓			✓

		stabilization of dispersions of nanoparticles, and self-organization of nanostructures in films and bulk structures are considered.									
9	Sustainable development strategies	Purpose: to foster comprehensive expertise and skills in formulating and executing sustainable development strategies across different tiers, to equip individuals with a profound understanding of sustainable development practices. Content: encompasses an extensive array of subjects, spanning from global environmental dilemmas like climate change, biodiversity loss, and natural resource exhaustion to socio-economic dimensions such as disparity, healthcare, and education.	5	✓	✓			✓	✓		
10	Thermodynamics	The discipline is intended for the study of thermodynamics, the implementation of a systematic study of physical processes and phenomena in energy systems, thermal devices and machines and methods for their mathematical description, to form a fundamental basis for the successful study of major	5			✓	✓	✓	✓		

		disciplines.									
11	Solid State Physics and Crystallography	The discipline studies the idea of the fundamental foundations of solid state physics and crystallography, the features of the crystal structure, the effect of defects on the properties of solids, a systematic understanding of the processes occurring in electronic media materials.	5	✓			✓		✓	✓	✓
12	Physical and chemical bases of materials	The discipline studies the basics of materials science and fundamental concepts and laws in the field of physics and chemistry, various phase diagrams and their construction. The course also examines the application of the laws of thermodynamics in the study of materials, in-depth studies of the theory of defects in crystalline solids, the processes of crystallization and recrystallization, methods of controlling the composition of composite materials.	5			✓		✓	✓		✓
Cycle of profile disciplines **University component**											
13	Application of quantum-size structures in micro-and nanoelectronics devices	The discipline studies quantum-dimensional structures that are the basis of modern micro- and nanoelectronics, fundamental laws that form the physical and chemical features of the synthesis of low-dimensional	5			✓		✓	✓		✓

		objects, their optical, structural and electrical properties, the basic physical principles of nanoelectronics, physico-chemical processes for obtaining solid-state low-dimensional structures, their application in nanoelectronics devices.									
14	Physics of the Atom and Atomic Nucleus	The discipline studies the development of ideas about the quantum properties of microparticles, allowing them to describe the structure and properties of the atom and the atomic nucleus, fundamental aspects such as wave-particle dualism and quantum mechanical aspects of the universe, considers various explanations of the structure of the atom, the atomic nucleus and compares with the modern classification of elementary particles.	5		✓	✓	✓			✓	
15	Fundamentals of Nanotechnologies	The discipline studies the fundamentals of obtaining nanoparticles and the processes of formation of nanostructures and nanomaterials, various methods for their synthesis, control of the growth of nanoparticles of the required	5			✓	✓		✓		✓

		sizes and shapes, the production of films and coatings using nanomaterials, as well as quality control of the obtained nanostructures and nanomaterials.									
16	Numerical methods for solving physical problems	This course studies the development of practical skills for the numerical solution of problems of classical and quantum physics using various methods: computational mathematics in accordance with the triad "model - algorithm - program", computational methods of linear algebra, differentiation and integration, ordinary differential equations and equations with partial derivatives, Monte Carlo methods, choose adequate solution algorithms and write programs in MATLAB.	5	✓		✓			✓		
Cycle of profile disciplines Elective component											
17	Electron and sonde microscopy for studying of nanomaterials	The discipline studies the device and the main characteristics of transmission electron and probe atomic force microscopy devices, the course also examines the	5			✓	✓	✓		✓	✓

		theory of formation and interpretation of the obtained images, get theoretical and practical skills of working with transmission electron and probe atomic force microscopes.									
18	Materials for energy storage and conversion	The discipline studies the physical foundations of the realization of the phenomena of the photoelectric effect, thermoelectronic emission and the Seebeck-Peltier-Thompson effect and forms an understanding of the principles of functioning of photovoltaic, thermoemission and thermoelectric energy converters.	5	✓			✓		✓	✓	✓
19	Materials with special technological properties	The discipline studies the theoretical foundations of the formation of special or special properties in metal materials for various purposes. Materials with special technological properties are considered from the point of view of regulating their physico-chemical properties, methods and processing modes.	5	✓		✓		✓			✓
20	Multiphase structures and methods for calculating phase diagrams	This course studies the scientific foundations of theoretical methods for	5	✓	✓			✓	✓		

		calculating phase diagrams of metal systems, in the ability to make flowcharts and computer programs for calculating phase diagrams, in constructing isothermal and polythermal sections of phase diagrams of multicomponent systems by calculation.									
21	Semiconductor’s Structures	The discipline studies the basic physical properties of low-dimensional semiconductor structures, the principles of dimensional quantization and the conditions for observing quantum-dimensional phenomena are studied. The course examines optical properties and kinetic features in magnetic fields, features of the density function of states and statistics of charge carriers.	5				✓		✓		✓
22	Practical perspective of X-ray diffratometry	The discipline studies the issues of research of metals and alloys using X-rays, the theoretical foundations of X-ray structural analysis, mastering X-ray methods of structural research, working on X-ray machines and using structural research data to solve structural analysis	5			✓	✓		✓		✓

		problems.									
23	Project Management	The discipline studies the components of project management based on modern behavioral models of project-oriented business development management. The program is based on the international standards PMI PMBOK, IPMA ICB and the standards of the Republic of Kazakhstan in the field of project management. The features of organizational management of business development through the interaction of strategic, project and operational management are studied.	5	✓	✓			✓			
24	Production, properties, application of carbon low-dimensional materials.	The discipline studies low-dimensional carbon materials such as graphene, carbon nanotubes and fullerenes. These materials are considered from the point of view of their use in opto- and nanoelectronic devices. Technologies for their production, physicochemical properties, establishing the relationship between production methods and properties, as well as the possibility of using carbon nanostructures and composites	5			✓	✓	✓			✓

		based on them are also being studied.									
25	The modern theory of the atomic nucleus	The discipline studies modern models of the atomic nucleus, the basic concepts, ideas and methods of the modern theory of elementary particles, the results of modern research conducted at the Large Hadron Collider to study particles such as the Higgs Boson, explains the features of string theory.	5	✓		✓			✓		✓
26	Spectral methods for studying low-dimensional objects	The discipline studies the analytical capabilities of mass spectrometric methods for studying the elemental analysis of inorganic substances and functional materials, X-ray fluorescence analysis using synchrotron radiation, as well as the use of infra-red Fourier spectrometry to study the properties of low-dimensional objects.	5			✓		✓	✓		✓

5. Curriculum of educational program

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

SATBAYEV UNIVERSITY

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

WORKING CURRICULUM

Academic year	**2025-2026 (Autumn, Spring)**
Group of educational programs	**M090 - "Physics"**
Educational program	**7M05301 - "Applied and engineering physics"**
The awarded academic degree	**Master of science in Natural Sciences**
Form and duration of study	**full time (scientific and pedagogical track) - 2 years**

Discipline code	Name of disciplines	Block	Cycle	Total ECTS credits	Total hours	lek/lab/pr Contact hours	in hours SIS (including TSIS)	Form of control	Allocation of face-to-face training based on courses and semesters				Prerequisites
									1 course		2 course		
									1 sem	2 sem	3 sem	4 sem	
CYCLE OF GENERAL EDUCATION DISCIPLINES (GED)													
CYCLE OF BASIC DISCIPLINES (BD)													
M-1. Module of basic training													
LNG213	Foreign language (professional)		BD, UC	3	90	0/0/30	60	E	3				
HUM214	Psychology of management		BD, UC	3	90	15/0/15	60	E	3				
HUM212	History and philosophy of science		BD, UC	3	90	15/0/15	60	E		3			
HUM213	Higher school pedagogy		BD, UC	3	90	15/0/15	60	E		3			
M - 2. Module of theoretical training													
PHY292	Solid State Physics and Crystallography	1	BD, CCH	5	150	30/0/15	105	E	5				
PHY244	Thermodynamics	1	BD, CCH	5	150	30/0/15	105	E	5				
MNG781	Intellectual property and research	1	BD, CCH	5	150	30/0/15	105	E	5				
M - 3. Materials Science Module													
PHY291	Materials science and advanced materials technology	1	BD, CCH	5	150	30/0/15	105	E	5				
PHY774	Materials and components for micro- and nanoelectronics	1	BD, CCH	5	150	30/0/15	105	E	5				
M-4. Nanotechnology module													
PHY295	Synthesis Methods of Nanomaterials and Nanostructures	1	BD, CCH	5	150	30/0/15	105	E			5		
PHY279	Information technologies in science and production	1	BD, CCH	5	150	15/0/30	105	E			5		
MNG782	Sustainable development strategies	1	BD, CCH	5	150	30/0/15	105	E			5		
M-7. Practice-oriented module													
AAP273	Pedagogical practice		BD, UC	8				R			8		
CYCLE OF PROFILE DISCIPLINES (PD)													
M - 3. Materials Science Module													
MNG705	Project Management	1	PD, CCH	5	150	30/0/15	105	E			5		
PHY775	Quantum technologies and quantum engineering	1	PD, CCH	5	150	30/0/15	105	E			5		
PHY772	Advanced Structural Materials		PD, UC	4	120	30/0/15	75	E				4	
M-4. Nanotechnology module													
PHY700	Production, properties, application of carbon low-dimensional materials.	2	PD, CCH	5	150	30/0/15	105	E			5		
PHY266	Materials for energy storage and conversion	2	PD, CCH	5	150	15/0/30	105	E			5		

M-6. R&D module													
PHY701	Electron and sonde microscopy for studying of nanomaterials	1	PD, CCH	5	150	30/0/15	105	E			5		
PHY299	Spectral methods for studying low-dimensional objects	1	PD, CCH	5	150	30/0/15	105	E			5		
M-7. Practice-oriented module													
AAP256	Research practice		PD, UC	4				R				4	
M-8. Experimental research module													
AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R	4				
AAP268	Research work of a master's student, including internship and completion of a master's thesis		RWMS	4				R		4			
AAP251	Research work of a master's student, including internship and completion of a master's thesis		RWMS	2				R			2		
AAP255	Research work of a master's student, including internship and completion of a master's thesis		RWMS	14				R				14	
M-5.													
PHY293	Numerical methods for solving physical problems		PD, UC	5	150	30/0/15	105	E	5				
PHY777	Applied optoelectronics and photonics		PD, UC	5	150	30/0/15	105	E	5				
PHY296	Physics of the Atom and Atomic Nucleus		PD, UC	5	150	30/0/15	105	E		5			
PHY298	Application of quantum-size structures in micro-and nanoelectronics devices		PD, UC	5	150	30/0/15	105	E		5			
PHY297	Practical perspective of X-ray diffratometry	1	PD, CCH	5	150	30/0/15	105	E		5			
PHY778	Physico-chemical bases of lithium-ion energy sources	1	PD, CCH	5	150	30/0/15	105	E		5			
PHY255	Semiconductor's Structures	2	PD, CCH	5	150	30/0/15	105	E		5			
PHY267	Materials with special technological properties	2	PD, CCH	5	150	15/0/30	105	E		5			
M-9. Module of final attestation													
ECA212	Registration and protection of the master thesis		FA	8								8	
Total based on UNIVERSITY:									30	30	30	30	
									60		**60**		

Number of credits for the entire period of study

Cycle code	Cycles of disciplines	Credits			
		Required component (RC)	University component (UC)	Component of choice (CCH)	Total
GED	Cycle of general education disciplines	0	0	0	0
BD	Cycle of basic disciplines	0	20	15	35
PD	Cycle of profile disciplines	0	28	25	53
Total for theoretical training:		**0**	**48**	**40**	**88**
RWMS	Research Work of Master's Student				24
ERWMS	Experimental Research Work of Master's Student				0
FA	Final attestation				8
TOTAL:					**120**

Decision of the Educational and Methodological Council of KazNRTU named after K.Satpayev. Minutes № 3 dated 20.12.2024

Decision of the Academic Council of the Institute. Minutes № 4 dated 12.12.2024

Signed:

Governing Board member - Vice-Rector for Academic Affairs	Uskenbayeva R. K.

Approved:

Vice Provost on academic development	Kalpeyeva Z. Б.
Head of Department - Department of Educational Program Management and Academic-Methodological Work	Zhumagaliyeva A. S.
Director - Mining and Metallurgical Institute named after O.A. Baikonurov	Rysbekov K. .
Department Chair - Materials Science, Nanotechnology and Engineering Physics	Kakimpv U. K.
Representative of the Academic Committee from Employers ____Acknowledged____	Mutushev A. Z.