Ministry of Higher Education and Science of the Republic of Kazakhstan
Kazakh National Research Technical University after K.I. Satpayev
Mining and Metallurgical Institute named after O. A. Baikonurov

APPROVED
Director of M&MI
_____ B. Rysbekov
_____2025.

Model of a specialist

8D05301 – Applied and Engineering Physic
(Doctor of Philosophy)

Almaty 2025

1 Brief description of the educational program 8D05301 – Applied and Engineering Physic

The purpose of the educational is to provide fundamental training for PhD students to successfully solve scientific and engineering problems, develop skills in engineering analysis and design, design and conduct scientific research, including as a leader or team member.

Tasks of educational program:

In accordance with the professional competencies of a Doctor of Philosophy (PhD) trained within the educational program "Applied and Engineering Physics", the objectives of the program are:

- to integrate fundamental training and applied skills for the successful solution of scientific and engineering problems in the field of applied physics;
- to develop physical-mathematical and physical-chemical methods and processes to optimize their parameters;
- to conduct research using original and modified experimental setups in the field of physics.

Types of labor activity

Graduates of the educational program 8D05301 – Applied and Engineering Physics can carry out the following types of professional activities:

- research activity;
- scientific and pedagogical activity;
- engineering and technological activity;
- organizational and managerial activity.

Objects of professional activity

The objects of professional activity of the EP are:

- institutions of higher and postgraduate education;
- research institutes and scientific laboratories in the field of applied and engineering physics;
- research and development centers and technology parks;
- high-tech industrial enterprises (electronics, semiconductor industry, energy, nanotechnology);
- engineering and design organizations engaged in the development of physical technologies and devices;
- enterprises involved in the development and production of modern materials, electronic and optoelectronic devices.

2 Descriptors of the level and scope of knowledge, skills and competencies

Level 3 descriptors within the **Comprehensive Framework for Qualifications of the European Higher Education Area (QF-EHEA)** reflect learning outcomes that characterize the doctoral student's ability to:

1. demonstrate a systematic and advanced understanding of applied and engineering physics, mastering modern theoretical approaches, experimental techniques and research methods used in the study of physical processes, materials and engineering systems;
2. demonstrate the ability to think critically, design, implement and adapt a complex research process using advanced scientific methodologies and modern experimental or computational tools;
3. contribute through original scientific research to the development of applied and engineering physics, expanding the boundaries of knowledge and producing results worthy of publication in national and international peer-reviewed scientific journals;
4. critically analyze, evaluate and synthesize new and complex scientific ideas, theories and experimental results in the field of physics and related interdisciplinary areas;
5. effectively communicate scientific knowledge, research results and technological developments to colleagues, the international scientific community and society through scientific publications, conferences and academic collaboration;
6. promote technological, scientific and innovative development of society in academic, research and industrial contexts through the application of advanced physical knowledge and research results.

3. Requirements for applicants

Persons with a master's degree are admitted to doctoral studies.

Enrollment in doctoral programs is carried out by the admissions committees of universities and scientific organizations based on the results of entrance examinations for groups of educational programs of doctoral studies and the availability of a certificate confirming proficiency in a foreign language in accordance with the pan-European competencies (standards) of foreign language proficiency.

When enrolling in universities, applicants independently choose an educational program from the corresponding group of educational programs.

Enrollment of persons for targeted training of PhD doctors under the state educational order is carried out on a competitive basis.

The procedure for admission of citizens to doctoral studies is established in accordance with the "Model Rules for Admission to Education in Educational Organizations Implementing Educational Programs of Postgraduate Education."

The formation of a contingent of doctoral students is carried out through the placement of a state educational order for the training of highly qualified scientific and scientific-pedagogical personnel, as well as through tuition paid from the personal funds of citizens and other sources.

The state provides citizens of the Republic of Kazakhstan with the right to receive free postgraduate education on a competitive basis in accordance with the state educational order, if they receive education at this level for the first time.

At the time of admission, a doctoral student must possess all prerequisites necessary for mastering the relevant professional curriculum of the doctoral program. The list of required prerequisites is determined independently by the higher education institution.

In the absence of the necessary prerequisites, the doctoral student is allowed to master them on a paid basis. In this case, doctoral training begins after the applicant has fully completed the prerequisite disciplines.

4. Requirements for completing studies and obtaining a diploma

Persons who have successfully completed the doctoral educational program and defended a doctoral dissertation, upon a positive decision of the Dissertation Council, are awarded the degree of Doctor of Philosophy (PhD) and are issued a state-recognized diploma with a Diploma Supplement.

Graduates of the doctoral program are qualified to conduct independent scientific research, participate in national and international scientific projects, and carry out professional activities in higher education institutions, research organizations and high-tech industries.

4.1 Requirements for key competencies of graduates:

1) have an idea:

– about the main stages of development and evolution of physics and engineering sciences;

– about the subject, worldview and methodological specifics of natural sciences, especially applied and engineering physics;

– about scientific schools in the field of modern physics, materials science, nanotechnology and engineering physics, their theoretical and practical developments;

– about modern scientific concepts of world and Kazakhstani science in the field of applied and engineering physics;

– about the mechanisms for introducing scientific developments and technological innovations into industrial practice;

– about the norms of interaction in the international scientific community;

– about the pedagogical and scientific ethics of a researcher and university teacher.

2) know and understand:

– current trends, directions and patterns of development of modern physics, engineering physics and related interdisciplinary fields in the context of globalization and internationalization of science;

– the methodology and philosophy of scientific knowledge;

– achievements of world and Kazakhstani science in applied physics, materials science, nanotechnology and modern physical technologies;

– the social responsibility of science, technology and education for sustainable technological development;

– the importance of foreign language proficiency for scientific communication, publication activity and international cooperation.

3) be able to:

– organize, plan and implement independent scientific research in the field of applied and engineering physics;

– analyze, evaluate and compare various theoretical models, physical concepts and experimental results;

– analyze and process scientific information obtained from different sources, including scientific databases and digital research platforms;

– select and effectively apply modern experimental, computational and theoretical research methods;

– plan and predict their further professional and scientific development.

4) have skills:

– critical analysis, evaluation and synthesis of modern scientific theories and ideas in physics and engineering sciences;

– analytical, theoretical and experimental scientific activity;

– planning, modeling and forecasting the results of scientific research;

– public speaking and presentation of research results at international scientific forums, conferences and seminars;

– scientific writing and academic communication in international scientific journals;

– planning, coordination and implementation of complex scientific research projects;

– systematic understanding of the field of applied and engineering physics and the ability to demonstrate the effectiveness of selected research methods;

– participation in national and international scientific projects and interdisciplinary research collaborations;

– leadership, teamwork and management of research groups;

– responsible and creative attitude toward scientific and scientific-pedagogical activity;

– conducting patent searches and transferring scientific and technological knowledge using modern digital and innovation technologies;

– protection of intellectual property rights related to scientific discoveries and technological developments;

– effective professional communication in a foreign language.

5) be competent:

– in scientific and scientific-pedagogical activities in conditions of rapid development of science and increasing information flows;

– in conducting theoretical, experimental and computational research in the field of applied and engineering physics;

– in formulating and solving complex theoretical and applied problems in modern physics and engineering technologies;

– in professional and comprehensive analysis of scientific and technological problems in the relevant field;

– in university-level training of specialists in physics and engineering disciplines;

– in ensuring continuous professional, scientific and technological development.

4.2 Requirements for R&D of a PhD student:

1) compliance with the main research directions of the doctoral educational program "Applied and Engineering Physics", within which the doctoral dissertation is carried out;

2) relevance of the research topic and the presence of scientific novelty and practical significance in the field of applied and engineering physics;

3) based on modern theoretical, methodological and technological achievements of contemporary physics, engineering sciences and interdisciplinary research;

4) based on modern methods of data acquisition, processing and interpretation using advanced computer technologies and computational modeling;

5) performed using modern experimental, theoretical and computational methods of scientific research;

6) contains research (theoretical, methodological and practical) sections that substantiate the main provisions submitted for defense.

4.3 Requirements for the organization of practices:

Practice is carried out in order to develop practical skills in scientific, scientific-pedagogical and professional activities.

The doctoral educational program includes:

1. pedagogical practice;
2. research practice (research internship).

During the period of pedagogical practice, doctoral students may be involved in conducting lectures, seminars and laboratory classes for undergraduate and master's students.

The research practice of a doctoral student is carried out with the aim of studying the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as developing practical skills in applying modern research methods, processing and interpreting experimental data within the framework of doctoral dissertation research.

The content of research practice is determined by the topic of the doctoral dissertation and the scientific direction of the doctoral student's research.

5 Requirements for the level of education of the graduate

5.1 Requirements for general education

The main requirement for general education is that the graduate receives a comprehensive and high-quality professional education, confirmed by the level of knowledge, skills, abilities and competencies in accordance with the criteria established by the state educational standards. The level of training should meet both the content and volume requirements of doctoral education.

5.2 Requirements for social and ethical competence

A graduate must possess a high level of humanitarian culture, adhere to ethical and legal norms in relations with individuals, society and the environment, and demonstrate a developed culture of thinking and professional responsibility.

5.3 Requirements for economic and organizational and managerial competencies

The graduate must understand the basic principles and laws of economic development, factors affecting the technical and economic efficiency of scientific and technological activities, and possess knowledge in the field of resource-efficient and renewable energy technologies. The graduate should be able to justify managerial decisions using qualitative and quantitative analysis.

5.4 Requirements for professional competence

The graduate must possess advanced professional knowledge in the field of applied and engineering physics and demonstrate understanding of the fundamentals of scientific research, innovation management and technological development, taking into account technical, financial and human factors.

The graduate must have a comprehensive system of knowledge related to the development and application of modern physical technologies in their field and related interdisciplinary areas. According to the chosen educational trajectory and research direction, the graduate must possess sufficient knowledge, skills and competencies for the formulation and solution of complex scientific, engineering and research problems.