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

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«___» _____ 2025.

Model of a specialist

6B07109 – Engineering physics and materials science
(Bachelor's degree)

Almaty 2025

1 Brief description of the educational program 6B07109 - Engineering physics and materials science

A bachelor in Engineering physics and materials science is a multidisciplinary specialist with fundamental knowledge in physics, materials science, engineering technologies, and modern analytical methods. The graduate is capable of solving scientific and applied problems related to the development, characterization, processing, and application of advanced materials.

The specialist is prepared to work in research laboratories, industrial enterprises, high-tech manufacturing sectors, and engineering companies involved in materials production, testing, and technological development.

Tasks of educational program:

- to deepen systemic knowledge among undergraduates, allowing them to give a critical assessment of the problems studied and discussed in the framework of modern production;
- develop skills in the analysis of new materials and research equipment based on the use of modern digital technologies;
- deepen the ability to work with modern foreign and domestic scientific literature and give their own assessment of the events in the creation of new materials;
- to expand fluency in English, which is necessary for writing scientific articles, reading foreign scientific literature, continuing education in foreign educational institutions, participating in international conferences and in negotiations with foreign partners;
- to develop the ability to contribute to the development of the latest trends in the research of advanced materials through original scientific research.

Areas of Professional Activity

Graduates of this program can work in the following sectors:

- Materials science and engineering industries
- Metallurgical and manufacturing enterprises
- Nanotechnology and high-tech industries
- Electronics and semiconductor industries
- Research institutes and laboratories
- Engineering and testing centers
- Quality control and certification organizations
- Educational institutions and scientific organizations

Objects of Professional Activity

The main objects of professional activity include:

- Metallic and non-metallic materials
- Nanomaterials and nanostructures
- Composite materials
- Semiconductor and functional materials
- Thin films and coatings
- Materials used in mechanical, electronic, and energy systems
- Technological processes of materials production and processing
- Equipment and devices for materials testing and diagnostics

Types of Professional Activity

Graduates are trained to perform the following types of professional activities:

Research Activity

- Investigation of physical properties of materials.
- Experimental study of structure and characteristics of materials.
- Participation in scientific research projects.

- Analysis and interpretation of experimental data.

Engineering and Technological Activity

- Selection and application of materials in engineering systems.
- Development and optimization of technological processes for materials production.
- Implementation of modern materials in industrial applications.

Design and Engineering Activity

- Design of materials and components with specified properties.
- Modeling and simulation of physical processes in materials.
- Application of engineering software and computational methods.

Production and Technological Activity

- Organization and control of technological processes.
- Monitoring product quality and material performance.
- Implementation of modern manufacturing technologies.

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

Key Competencies of the Graduate

General (Universal) Competencies

The graduate should be able to:

- Apply fundamental knowledge of mathematics, physics, and chemistry in engineering practice
- Think analytically and solve complex engineering problems
- Work effectively individually and in multidisciplinary teams
- Communicate professionally in native and foreign languages
- Use modern information technologies and digital tools
- Demonstrate responsibility, ethical behavior, and professional integrity

Professional Competencies

The graduate must be able to:

- Analyze the structure and properties of engineering materials
- Apply modern experimental methods for materials characterization
- Use physical principles to design and develop new materials
- Conduct laboratory experiments and process experimental data
- Apply nanotechnology and advanced materials technologies
- Use specialized software for modeling and simulation of materials processes
- Perform quality control and materials diagnostics
- Evaluate reliability and performance of materials in engineering systems

Expected Learning Outcomes

Upon completion of the program, graduates will be able to:

1. Apply fundamental laws of physics, chemistry, and materials science to solve engineering problems.
2. Analyze structure–property relationships in engineering materials.
3. Conduct experimental studies using modern laboratory equipment.
4. Process and interpret experimental data using digital and analytical tools.
5. Design materials with specified physical and mechanical properties.
6. Apply nanotechnology and advanced materials technologies in engineering practice.
7. Use simulation and modeling tools to study materials behavior.
8. Ensure quality control and reliability of materials in industrial applications.
9. Work effectively in research and engineering teams.
10. Continuously develop professional knowledge and skills.

Personal and Professional Qualities of the Specialist

A graduate of the program should demonstrate:

- Analytical and critical thinking
- Creativity and innovation in solving engineering problems
- Responsibility and professional ethics
- Ability for lifelong learning and professional development
- Adaptability to rapidly evolving technologies

3. Requirements for applicants

General Academic Requirements

Applicants must have:

- Completed secondary education (secondary school certificate or equivalent).
- Eligibility to enter higher education institutions in Kazakhstan.
- Submission of all required admission documents to the university admissions office.
- The duration of study in the program is 4 years (full-time) and graduates receive the Bachelor of Engineering and Technology degree.

Applicants entering after secondary school must:

- Pass the Unified National Testing (UNT).
- Achieve the minimum threshold score of 65 points for admission to technical educational programs.

*Applicants entering based on **technical college diplomas** may:*

- Submit **UNT results**, or
- Pass an **interview or internal assessment** at the university depending on the specialization and admission rules.

Required UNT profile subjects

For engineering programs such as **Engineering Physics and Materials Science**, the typical profile subjects are:

- **Mathematics**
- **Physics**

These subjects reflect the scientific and engineering orientation of the program.

Applicants are expected to have:

- Strong background in **physics and mathematics**
- Analytical and problem-solving abilities
- Interest in **materials science, nanotechnology, and engineering physics**
- Basic computer and scientific literacy

4. Requirements for completing studies and obtaining a diploma

Successful completion of the bachelor's educational program 6B07109 – Engineering physics and materials science and the awarding of a diploma are based on the fulfillment of academic, professional, and institutional requirements established by the university and the higher education standards of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

To obtain a bachelor's degree, students must fully complete the curriculum of the educational program. This includes:

- Successful completion of all compulsory and elective courses specified in the curriculum.
- Mastery of theoretical and practical components of engineering physics and materials science.
- Participation in laboratory work, seminars, and independent study.

Fulfillment of all academic requirements within the established study period (typically 4 years for full-time study).

Students must accumulate the required number of academic credits according to the **European Credit Transfer and Accumulation System (ECTS)** used in Kazakhstan.

Typical requirements include:

- **At least 240 ECTS credits** for a bachelor's degree
- Credits obtained through coursework, laboratory work, professional practice, and final assessment activities

Only students who successfully earn all required credits may proceed to the final certification stage.

The program requires students to complete several types of professional practice designed to develop practical engineering skills, including:

- Educational (introductory) practice.
- Industrial or technological practice.
- Pre-diploma practice.

These practices allow students to apply theoretical knowledge in real engineering or research environments and gain professional experience in materials science and engineering physics.

Students must successfully pass the **final attestation**, which confirms that the graduate has achieved the learning outcomes of the program.

Final attestation may include:

- **Defense of a bachelor's thesis (diploma project)** or
- **Comprehensive final examination**

The bachelor's thesis typically involves:

- Research or engineering analysis in materials science or applied physics.
- Application of experimental, analytical, or computational methods.
- Presentation and defense before an academic examination committee.

To graduate, students must:

- Maintain the minimum cumulative GPA required by the university
- Successfully pass all examinations and course assessments
- Meet attendance and academic integrity requirements
- Fulfill all administrative and academic obligations

Students who fail to meet academic standards may be required to retake courses or extend their period of study.

After fulfilling all academic and institutional requirements, graduates are awarded the bachelor's degree in engineering physics and materials science by Satbayev University.

The graduate receives state-recognized diploma of higher education.

Diploma supplement, which includes information about the completed courses, credits, and achieved learning outcomes.

Graduates of the program may:

- Continue studies in Master's degree programs in materials science, applied and engineering physics, nanotechnology, or related fields.
- Work in research institutions, high-tech industries, engineering companies, and materials testing laboratories.

4.1 Requirements for key competencies of graduates:

1) *have an idea*:

- Modern trends in **engineering physics and materials science**
- The role of advanced materials in modern technologies and industrial development
- Basic principles of nanotechnology, semiconductor physics, and functional materials
- Global challenges related to energy, environment, and sustainable materials development
- Ethical standards and professional responsibility in scientific and engineering activity
- The structure and functioning of research and industrial organizations

2) *know and understand*:

- Fundamental laws and principles of **physics, mathematics, and materials science**
- Structure, properties, and classification of engineering materials

- Physical mechanisms that determine mechanical, electrical, thermal, and magnetic properties of materials
- Methods of materials synthesis, processing, and modification
- Principles of operation of laboratory equipment and measurement systems
- Methods of materials characterization (microscopy, spectroscopy, mechanical testing, etc.)
- Basics of computational modeling and simulation of physical processes in materials
- Standards and methods of quality control in engineering production

be able to:

- Apply theoretical knowledge of physics and materials science to engineering problems
- Analyze the relationship between **structure, composition, and properties of materials**
- Conduct laboratory experiments and interpret experimental results
- Select appropriate materials for engineering applications
- Use modern information technologies and specialized software for data processing and modeling
- Design and optimize technological processes related to materials production and processing
- Work effectively both independently and as part of interdisciplinary teams
- Present scientific and technical information clearly in written and oral form

3) *have practical skills in*:

- Working with modern laboratory equipment and measurement instruments
- Experimental research and testing of materials
- Data analysis using engineering and scientific software
- Preparation of technical reports, research papers, and project documentation
- Implementation of quality control procedures for materials and products
- Application of digital tools and engineering technologies in research and production processes
- Organization and planning of experimental and engineering work

4) *be competent*:

- Solving engineering and scientific problems in materials science and applied physics
- Development and application of advanced materials in industrial technologies
- Conducting research and innovation activities in engineering fields
- Evaluation of material performance and reliability in technical systems
- Implementation of modern technological solutions in manufacturing and high-tech industries
- Continuous professional development and adaptation to rapidly evolving technologies
- Observance of professional ethics, safety standards, and environmental responsibility

4.2 Requirements for R&D of a student:

The main objectives of student research and development activities are:

- Development of scientific and analytical thinking
- Acquisition of practical skills in experimental and theoretical research
- Application of fundamental knowledge in physics and materials science to real scientific and engineering problems
- Involvement of students in innovative and research projects
- Preparation of students for further studies at the **Master's and PhD levels**

Student R&D activities may be carried out in various forms, including:

- Participation in scientific research projects conducted at the university
- Work in scientific laboratories and research centers
- Preparation of scientific reports, essays, and research papers
- Participation in student scientific conferences and seminars
- Publication of research results in scientific journals or conference proceedings
- Participation in competitions, innovation projects, and scientific exhibitions

Students may conduct research under the supervision of academic staff and researchers of

Satbayev University.

Research activities are integrated into the curriculum through:

- Laboratory and experimental work
- Research-oriented coursework and term projects
- Participation in research seminars and workshops
- **Pre-diploma research activities**
- Preparation and defense of the **bachelor's thesis (diploma project)**

These activities allow students to gain experience in the **planning, implementation, and analysis of scientific research.**

4.3 Requirements for the organization of practices:

The main purpose of organizing student practices is to:

- Consolidate theoretical knowledge obtained during academic studies
- Develop professional and practical skills in engineering physics and materials science
- Familiarize students with modern technologies, equipment, and industrial processes
- Prepare students for independent professional activity
- Strengthen cooperation between the university and industrial enterprises and research institutions

The educational program includes several types of practice conducted at different stages of study:

Educational (Introductory) Practice

Educational practice is usually organized in the early years of study and aims to:

- Introduce students to the basics of engineering and research activities
- Familiarize them with laboratory equipment and safety procedures
- Provide initial practical skills in working with materials and measurement instruments

Industrial (Technological) Practice

Industrial practice is conducted at enterprises, research laboratories, or engineering organizations and is aimed at:

- Applying theoretical knowledge in real production or research conditions
- Studying technological processes of materials production, processing, and testing
- Gaining experience in working with industrial equipment and engineering systems

Pre-Diploma Practice

Pre-diploma practice is carried out in the final stage of study and is closely connected with the preparation of the **bachelor's thesis**. Its objectives include:

- Collecting experimental or technical data for the diploma project
- Performing research or engineering tasks related to the thesis topic
- Developing professional independence in solving engineering problems

The organization of practices is carried out by the relevant academic departments of Satbayev University in cooperation with partner organizations such as:

- Industrial enterprises
- Research institutes and laboratories
- Engineering and technology companies
- Materials testing and certification centers

Each student is assigned:

- **A university supervisor** responsible for academic guidance
- **A workplace supervisor** responsible for practical training at the organization

5 Requirements for the level of education of the graduate

5.1 Requirements for general education

Graduates must possess a broad fundamental education that provides the basis for professional and intellectual development. They should:

- Demonstrate knowledge of fundamental disciplines such as **mathematics, physics, chemistry, and information technologies**
- Understand the basic principles of natural sciences and their application in engineering practice
- Be able to analyze scientific and technical information using modern information technologies
- Communicate effectively in written and oral forms in the **state, Russian, and/or foreign languages**
- Demonstrate the ability for **critical thinking, problem solving, and independent learning**
- Understand the role of science, technology, and innovation in modern society

5.2 Requirements for social and ethical competence

Graduates must demonstrate social responsibility and adherence to ethical standards in professional and public activities. They should:

- Understand and follow **professional ethics and academic integrity principles**
- Respect cultural diversity and social values
- Demonstrate responsibility for the results of professional activities
- Be able to work effectively in **multidisciplinary and multicultural teams**
- Understand the social significance of engineering decisions and their impact on society and the environment
- Follow safety standards, environmental protection principles, and sustainable development practices

5.3 Requirements for economic and organizational and managerial competencies

Graduates should possess basic knowledge and skills in the field of economic and organizational activities related to engineering practice. They should:

- Understand the **economic principles of production and technological processes**
- Be able to evaluate the economic efficiency of engineering solutions and materials technologies
- Participate in the planning, organization, and management of engineering projects
- Apply basic methods of project management and resource allocation
- Understand the fundamentals of **innovation management and technology commercialization**
- Demonstrate the ability to organize teamwork and participate in decision-making processes

5.4 Requirements for professional competence

Graduates must possess professional competencies that enable them to perform engineering and research activities in the field of engineering physics and materials science. They should:

- Apply fundamental laws of **physics, materials science, and engineering** in solving professional problems
- Analyze the **structure, composition, and properties of materials** and their relationship to performance characteristics
- Conduct experimental research using modern laboratory equipment and measurement systems
- Use modern **analytical, computational, and modeling methods** in materials science
- Develop and optimize technologies for the synthesis, processing, and application of engineering materials
- Perform quality control and diagnostics of materials and products
- Participate in scientific research and innovation projects
- Prepare technical documentation, scientific reports, and engineering project materials