

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE REPUBLIC OF
KAZAKHSTAN

SATBAYEV UNIVERSITY

(Kazakh National Research Technical University named after K.I. Satbayev)

Module reference book or collection of module descriptions in the specialty

8D07103 "Materials Science and Engineering"

Almaty 2025

A module reference book or a collection of module descriptions, which is also available to students for review, should contain the following information about individual modules:

Module designation	Module of basic training
Semester(s) in which the module is taught	Autumn (1)
The person responsible for the module	Baytimbetova B.A.
Language	Kazakh / Russian / English
Attitude to the curriculum	Cycle of Basic Disciplines (BD) – University and Component of Choice
Teaching methods	Lecture, laboratory classes, practical classes, independent work of students
Workload (including contact hours, self-study hours)	Total workload: 25 ECTS (750 hours) Approximate distribution: Contact hours (practical classes) – 225 hours Independent study – 525 hours
Credits	25 ECTS
Necessary and recommended prerequisites for joining the module	Master’s degree in Materials Science, Engineering Physics, or related field Research experience at master’s level Basic academic writing and research methodology competencies
Module objectives / expected learning outcomes	The aim of the module is to develop advanced theoretical, methodological, and interdisciplinary competencies required for independent doctoral research. Upon completion of the module, doctoral students are able to: <ul style="list-style-type: none"> • critically evaluate scientific paradigms and research methodologies; • develop and justify original research approaches; • produce high-level academic texts suitable for peer-reviewed international journals; • integrate sustainability principles into advanced materials research; • analyze and improve advanced structural hardening technologies; • apply interdisciplinary knowledge in energy-saving and renewable energy materials research; • demonstrate academic integrity and ethical research conduct. The module forms the methodological and conceptual foundation for doctoral-level scientific work.
Description	This module provides advanced theoretical and methodological training for doctoral students. It includes academic writing for high-impact publications, advanced research methodology, structural strengthening technologies, energy-efficient materials and renewable energy technologies, and sustainability science. The module emphasizes critical thinking, independent research planning, interdisciplinary integration, and preparation

	for international scientific publication. It establishes the theoretical and methodological basis necessary for successful completion of doctoral research.
Exams and assessment formats	Assessment includes analytical essays, research proposals, scientific article drafts, presentations, and written examinations. Evaluation focuses on originality of thought, methodological rigor, analytical depth, and ability to formulate independent research strategies. Assessment is conducted according to university regulations.
Requirements for studies and exams	Successful completion of the module requires active participation in seminars, submission of research-oriented assignments, preparation of publishable academic texts, and successful passing of final examinations. Doctoral students must obtain at least 60 out of 100 total points in each discipline.
Reading list	<ol style="list-style-type: none"> 1. Creswell, J. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage. 2. Booth, W., Colomb, G., Williams, J. The Craft of Research. University of Chicago Press. 3. Ashby, M. Materials Selection in Mechanical Design. Butterworth-Heinemann. 4. Callister, W., Rethwisch, D. Materials Science and Engineering. Wiley. 5. Selected peer-reviewed articles in Acta Materialia, Advanced Materials, Materials & Design, Energy Materials.

Module designation	Practice-oriented module
Semester(s) in which the module is taught	Spring (2)
The person responsible for the module	Baytimbetova B.A.
Language	Kazakh / Russian / English
Attitude to the curriculum	Basic and Profile Disciplines Cycles (BD / PD), University Component (UC)
Teaching methods	Lecture, practical classes, independent work of students
Workload (including contact hours, self-study hours)	Total workload: 10 ECTS
Credits	10 ECTS
Necessary and recommended prerequisites for joining the module	Enrollment in the PhD program Completion of initial theoretical training Approved individual doctoral study plan
Module objectives / expected learning outcomes	The aim of the module is to develop advanced pedagogical and research competencies required for academic and scientific careers. Upon completion of the module, doctoral students are able to: <ul style="list-style-type: none"> • independently design and deliver lectures and seminars in higher education;

	<ul style="list-style-type: none"> • apply modern teaching methodologies and digital educational technologies; • supervise student research projects; • organize and conduct advanced laboratory and experimental research; • integrate research findings into educational processes; • demonstrate leadership and professional responsibility in academic environments. <p>The module prepares doctoral students for academic teaching and high-level research activity.</p>
Description	The Practice-Oriented Module includes pedagogical and research practice. Pedagogical practice involves preparation and delivery of lectures, seminars, and laboratory sessions under supervision, development of educational materials, and participation in assessment procedures. Research practice involves advanced experimental work, collaboration with research laboratories or industrial partners, participation in research projects, and integration of research outcomes into doctoral dissertation work. The module ensures alignment between teaching, research, and innovation activities at the doctoral level.
Exams and assessment formats	<p>Assessment is based on:</p> <ul style="list-style-type: none"> • Supervisor evaluation; • Teaching performance assessment; • Research activity reports; • Presentation and defense of practice outcomes before a departmental committee. <p>Evaluation follows university regulations and doctoral-level academic standards.</p>
Requirements for studies and exams	Successful completion requires full implementation of the approved practice plan, submission of detailed reports, documented teaching activities, and confirmation of research contributions. Final evaluation is based on cumulative performance assessment and supervisor recommendation.
Reading list	<ol style="list-style-type: none"> 1. Biggs, J., Tang, C. Teaching for Quality Learning at University. McGraw-Hill. 2. Creswell, J. Research Design. Sage. 3. Selected international guidelines on doctoral supervision and academic ethics. 4. University internal regulations for pedagogical and research practice.

Module designation	Module of professional activity
Semester(s) in which the module is taught	Autumn (1)
The person responsible for the module	Shalenov E., Baytimbetova B.A.

Language	Kazakh / Russian / English
Attitude to the curriculum	Cycle of Profile Disciplines (PD), Component of Choice (CCH)
Teaching methods	Lecture, practical classes, independent work of students
Workload (including contact hours, self-study hours)	Total workload: 20 ECTS (600 hours) Approximate distribution: Contact hours (practical classes) – 180 hours Independent study – 420 hours
Credits	20 ECTS
Necessary and recommended prerequisites for joining the module	Master's degree in Materials Science or related engineering field Advanced knowledge of solid-state physics and materials characterization Basic computational modeling skills
Module objectives / expected learning outcomes	The aim of the module is to develop high-level professional and analytical competencies required for independent scientific and technological activity in materials science. Upon completion of the module, doctoral students are able to: <ul style="list-style-type: none"> • formulate and solve complex applied problems in materials science; • analyze physical phenomena in low-dimensional structures and nanosystems; • develop and apply computational tools for modeling structure formation; • design and adapt physicochemical methods for advanced materials research; • critically evaluate technological and experimental approaches; • integrate theoretical modeling with experimental validation; • propose innovative solutions for advanced materials engineering challenges. The module strengthens the doctoral student's ability to operate at the frontier of materials science research.
Description	The Module of Professional Activity focuses on advanced theoretical and applied aspects of materials science. It includes study of complex applied problems, nanoscale physics, computational modeling of structure formation, and modern physicochemical characterization methods. Emphasis is placed on research-driven problem solving, integration of experimental and computational approaches, and critical evaluation of scientific methodologies. The module prepares doctoral students for leadership roles in research laboratories, high-technology industries, and academic institutions.
Exams and assessment formats	Assessment includes research-oriented assignments, analytical reviews of scientific literature, modeling projects, laboratory reports, and written examinations. Evaluation criteria

	emphasize originality, methodological rigor, analytical depth, and the ability to propose innovative research strategies.
Requirements for studies and exams	Successful completion requires active participation in seminars and research activities, submission of analytical and modeling projects, and successful completion of final examinations. Doctoral students must demonstrate advanced scientific reasoning and obtain at least 60 out of 100 total points in each discipline.
Reading list	<ol style="list-style-type: none"> 1. Kittel, C. Introduction to Solid State Physics. Wiley. 2. Ashcroft, N., Mermin, N. Solid State Physics. Cengage Learning. 3. Cullity, B., Stock, S. Elements of X-Ray Diffraction. Pearson. 4. Cao, G., Wang, Y. Nanostructures and Nanomaterials. World Scientific. 5. Selected publications in Acta Materialia, Nano Letters, Advanced Functional Materials, Physical Review B.

Module designation	Practice-oriented module
Semester(s) in which the module is taught	Autumn (1)
The person responsible for the module	Baytimbetova B.A.
Language	Kazakh / Russian / English
Attitude to the curriculum	Basic and Profile Disciplines Cycles (BD / PD), University Component (UC)
Teaching methods	Lecture, practical classes, independent work of students
Workload (including contact hours, self-study hours)	Total workload: 10 ECTS
Credits	10 ECTS
Necessary and recommended prerequisites for joining the module	Enrollment in the PhD program Completion of initial theoretical training Approved individual doctoral study plan
Module objectives / expected learning outcomes	<p>The aim of the module is to develop advanced pedagogical and research competencies required for academic and scientific careers. Upon completion of the module, doctoral students are able to:</p> <ul style="list-style-type: none"> • independently design and deliver lectures and seminars in higher education; • apply modern teaching methodologies and digital educational technologies; • supervise student research projects; • organize and conduct advanced laboratory and experimental research; • integrate research findings into educational processes; • demonstrate leadership and professional responsibility in academic environments.

	The module prepares doctoral students for academic teaching and high-level research activity.
Description	The Practice-Oriented Module includes pedagogical and research practice. Pedagogical practice involves preparation and delivery of lectures, seminars, and laboratory sessions under supervision, development of educational materials, and participation in assessment procedures. Research practice involves advanced experimental work, collaboration with research laboratories or industrial partners, participation in research projects, and integration of research outcomes into doctoral dissertation work. The module ensures alignment between teaching, research, and innovation activities at the doctoral level.
Exams and assessment formats	Assessment is based on: <ul style="list-style-type: none"> • Supervisor evaluation; • Teaching performance assessment; • Research activity reports; • Presentation and defense of practice outcomes before a departmental committee. Evaluation follows university regulations and doctoral-level academic standards.
Requirements for studies and exams	Successful completion requires full implementation of the approved practice plan, submission of detailed reports, documented teaching activities, and confirmation of research contributions. Final evaluation is based on cumulative performance assessment and supervisor recommendation.
Reading list	<ol style="list-style-type: none"> 5. Biggs, J., Tang, C. Teaching for Quality Learning at University. McGraw-Hill. 6. Creswell, J. Research Design. Sage. 7. Selected international guidelines on doctoral supervision and academic ethics. 8. University internal regulations for pedagogical and research practice.

Module designation	Experimental research module
Semester(s) in which the module is taught	Autumn, spring (1, 2, 3, 4, 5, 6)
The person responsible for the module	Baytimbetova B.A.
Language	Kazakh / Russian / English
Attitude to the curriculum	Research Work of Doctoral Student (RWDS) – Mandatory Component
Workload (including contact hours, self-study hours)	Total workload: 123 ECTS
Credits	123 ECTS

Necessary and recommended prerequisites for joining the module	Admission to the PhD program Approved doctoral research proposal Assigned scientific supervisor Completion of basic and profile discipline modules
Module objectives / expected learning outcomes	<p>The aim of the module is to generate original scientific knowledge and develop independent high-level research competence.</p> <p>Upon completion of the module, doctoral students are able to:</p> <ul style="list-style-type: none"> • formulate novel research hypotheses in materials science; • design and implement complex experimental programs; • develop and adapt advanced research methodologies; • integrate theoretical modeling and experimental validation; • critically analyze and synthesize international scientific literature; • publish research results in peer-reviewed international journals; • present research findings at international scientific conferences; • prepare and complete an original doctoral dissertation contributing new knowledge to the field. <p>This module ensures formation of an independent researcher capable of leading scientific projects.</p>
Description	<p>The Experimental Research Module constitutes the core of the doctoral program and is conducted continuously throughout all semesters of study. Doctoral students perform independent research aligned with the approved dissertation topic. Research activities may include:</p> <ul style="list-style-type: none"> • synthesis and processing of advanced materials; • nanoscale materials engineering; • physicochemical characterization; • structural analysis using advanced microscopy and spectroscopy; • computational modeling; • industrial testing and validation; • participation in international research internships. <p>The results of the module form the scientific basis of the doctoral dissertation and must meet international research standards.</p>
Exams and assessment formats	<p>Assessment is conducted through:</p> <ul style="list-style-type: none"> • Semester research reports; • Evaluation by the scientific supervisor; • Presentation of research progress at departmental seminars; • Publication of research results; • Confirmation of dissertation readiness for defense.

	Evaluation is based on research originality, methodological rigor, publication activity, and compliance with doctoral academic standards.
Requirements for studies and exams	<p>Successful completion requires:</p> <ul style="list-style-type: none"> • Continuous research progress; • Documented experimental results; • Participation in scientific seminars; • Preparation of scientific publications; • Positive evaluation by the scientific supervisor and department. <p>The final cumulative assessment confirms readiness for doctoral dissertation defense.</p>
Reading list	<ol style="list-style-type: none"> 1. Creswell, J. Research Design. Sage. 2. Booth, W., Colomb, G., Williams, J. The Craft of Research. University of Chicago Press. 3. Selected peer-reviewed publications in Acta Materialia, Advanced Materials, Nano Letters, Physical Review B, Materials & Design. 4. International standards and guidelines for doctoral research ethics and publication.

Module designation	Experimental research module
Semester(s) in which the module is taught	Spring (6)
The person responsible for the module	Baytimbetova B.A.
Language	Kazakh / Russian / English
Attitude to the curriculum	Final Attestation (FA) – Mandatory Component
Workload (including contact hours, self-study hours)	Total workload: 12 ECTS
Credits	12 ECTS
Necessary and recommended prerequisites for joining the module	<p>Successful completion of all theoretical modules (BD and PD)</p> <p>Successful completion of the Experimental Research Module (RWDS – 123 ECTS)</p> <p>Fulfillment of publication requirements in accordance with national and university regulations</p> <p>Approval of dissertation by scientific supervisor and department</p>
Module objectives / expected learning outcomes	<p>The aim of the module is to assess the doctoral candidate's ability to generate original scientific knowledge and defend an independent research contribution at the international level. Upon completion of the module, the doctoral candidate demonstrates the ability to:</p> <ul style="list-style-type: none"> • present an original scientific contribution to materials science; • justify the novelty and relevance of research results; • critically defend methodological approaches;

	<ul style="list-style-type: none"> • demonstrate advanced theoretical and experimental competence; • respond to expert questions at a professional research level; • contribute new scientific knowledge meeting international academic standards.
Description	<p>The Module of Final Attestation includes completion, submission, and public defense of the doctoral dissertation. The doctoral dissertation must represent an original, independently conducted research project contributing new scientific knowledge in the field of materials science and engineering. The work must meet international research standards and demonstrate methodological rigor, scientific novelty, and practical or theoretical significance. The defense is conducted before a Dissertation Council in accordance with national legislation and university regulations.</p>
Exams and assessment formats	<p>Assessment is conducted through:</p> <ul style="list-style-type: none"> • Public defense of the doctoral dissertation before the Dissertation Council. <p>Evaluation criteria include:</p> <ul style="list-style-type: none"> • Scientific novelty and originality; • Theoretical and methodological depth; • Quality of experimental or analytical results; • Publication record; • Practical or theoretical significance; • Quality of oral defense and responses to expert questions.
Requirements for studies and exams	<p>Admission to final attestation is granted to doctoral candidates who:</p> <ul style="list-style-type: none"> • Have completed all required credits of the doctoral program; • Have fulfilled research and publication requirements; • Have received positive reviews from scientific supervisor and independent reviewers; • Have obtained official permission for dissertation defense. <p>The final decision is made by the Dissertation Council according to established academic standards.</p>