NJSC "Kazakh National Research Technical University after K.I. Satpayev"
Institute of Industrial Engineering named after A. Burkitbayev
Department of Engineering Physics

CURRICULUM PROGRAM

APPLIED AND ENGINEERING PHYSICS

Master of Engineering Science

on the basis of the following specialties of the invalidated Classifier of specialties:
«6M074000 – Nanomaterials and nanotechnology»,
6M072300 – «Technical physics»

1st edition
in accordance with the State Educational Standard of Higher Education 2018

Almaty 2019

The program was drawn up and signed by the parties:
From KazNRTU named after K. Satpayev:
1. Head of EP Department _____ R.E. Beisenov
2. Director of Institute of IE _____ B.O. Omarbekov
3. Chairman of Sc. Method. Council of EP Department _____ Kh.R. Maylina

From employers:
LLP «Institute of Physics and Technology» _____ A.S. Serikkanov

Approved at a meeting of the Educational and Methodological Council of the Kazakh National Research Technical University named after K. Satpayev. Protocol №15 from 06.06.2019.

Qualification:
Level 7 of the National Qualifications Framework:
7M05 Natural sciences, mathematics and statistics
7M053 Physical sciences

Professional competence:
Ability to professionally operate modern scientific and technological equipment and instruments; the ability to demonstrate and use in-depth theoretical and practical knowledge of fundamental and applied sciences; the ability to carry out scientific research and development of new promising approaches and methods for solving professional problems of engineering physics, readiness for professional improvement and growth.

Short description of the program

This program is intended for the implementation of scientific and pedagogical training of Master's degree program in "Applied and Engineering Physics".

Master's students in "Applied and Engineering Physics" is preparing for the following professional activities:

- working in research institutes and higher educational institutions, in heavy, light, mining, metallurgical, aviation and space industries, construction and machine-building sectors of the economy, creation of new composite and functional materials;
- taking part in scientific and research studies, technical marketing, project planning, examination and management tasks, and analyzing data;
- performing professional skills in expert, industrial, and state research organizations engaged in the design, development, and creation of low-dimensional materials and technologies for the needs of the power supply industry, chemical industry, metallurgy, engineering, and medicine.

Awarded degree / qualifications: "Master of Engineering Science in Applied and Engineering Physics".

1 Purpose (mission) of educational program

The purpose of studying this educational program is to gain knowledge about the structure and properties of solid-state functional materials, manufacturing technologies and methods of their research, sufficient to understand their various applications.

The Master's program equips the students with the following general professional skills:

- to analyze and solve scientific and practical problems, organize and conduct research and innovation activities and carry out information-analytical and information-bibliographic work;
- critically evaluate existing concepts, theories, and approaches to the analysis of processes and phenomena, and integrate knowledge gained to solve research problems in particular research;
- to apply theoretical and experimental existing concepts, theory and approaches to interpret new ideas and trends in the field of creating new materials and compositions, processes and methods;
- to identify the physical and chemical properties of the developing materials and their compositions with the use of a modeling approach to optimize their parameters with practically useful properties;
- to generate ideas through the development of original methodologies and methods for creating innovative scientific and technological solutions that expand the scope of existing trends and concepts.

2 Types of professional activities:

- Scientific and pedagogical;
- Scientific research;
- Organization management;
- Project engineering.

3 The professional field:

- Organizations of the secondary education of all types, regardless of the form of ownership and departmental subjections;
- Organizations of technical and professional education;
- Higher educational institutions;
- Scientific research institutions.

PASSPORT OF THE EDUCATIONAL PROGRAM

1 Program scope and content

The study duration of the Master's program is determined by the amount of acquired academic credits. The prerequisite for the award of the Master's degree is proof that the attainments required in accordance with the established amount of credits points and successful completion of the modules have been achieved. For this Master's program, at least 120 academic credit points for the full period of study, including all types of educational and scientific activities must be attained.

The planning of a content of an educational program, procedure and conducting an educational process and the scientific organization is carried out by the university independently based on credit technology of education.

The master's degree in scientific and pedagogical direction implements educational programs of postgraduate education for the preparation of scientific, and scientific and pedagogical workers for universities and scientific organizations with in-depth scientific, pedagogical and research training.

Master's degree program consists of:

1) Theoretical training, including the study of cycles of basic and major disciplines;

2) Practical training of undergraduates: various types of practices, scientific or professional internships;

3) Scientific research work, including a master's thesis;

4) Final degree.

Educational program content

Graduates of the Master's degree program have profound specialist knowledge and are proficient in theoretical and practical methods in fields of materials, devices and systems, performance of which is determined by low-dimensional effects and principles of functioning. The professional field for graduates of the Master's degree program is wide-ranging from fundamental or industrial research to application-related development and technical marketing, planning, examination and management tasks in industry or administration.

The program is based on a combination of fundamental, general engineering and materials science disciplines, while also focusing on humanitarian disciplines, as well as IT-technologies.

Educational program aims:

To prepare undergraduates to conduct independent research in the field of physics of functional materials; and to the development of new highly efficient methods for creating modern materials; to conduct classes at the university as a teacher of practical classes, head of the practice of graduation work.

2 Requirements for applicants

The previous level of education of applicants is higher professional education (Bachelor's degree). The applicant must have a diploma of the established sample and confirm the level of knowledge of the English language with a certificate or diplomas of the established sample.

The procedure for admitting citizens to Master's program is established in accordance with the "Standard rules for admission to training in educational organizations that implement educational programs of postgraduate education."

The formation of a contingent of undergraduates is carried out by placing a state educational order for the training of scientific and pedagogical stuff, as well as paying for training at the expense of citizens' own funds and other sources. The state provides citizens of the Republic of Kazakhstan with the right to receive, on a competitive basis, in accordance with the state educational order, free postgraduate education, if they receive education of this level for the first time.

Applicants for the Master's degree must have all admission requirements necessary to apply to the corresponding educational program. The list of admission requirements is determined by the higher education institution independently.

In the absence of the necessary requirements, the Master's student is allowed to apply to the program on a paid basis.

3 Requirements for completing studies and conformation of the final degree

Awarded degree/qualifications: The graduate of this educational program is awarded the academic degree "Master" of technical sciences in the direction of Applied and Engineering Physics.

A graduate who has completed his Master's program must have the following general professional skills:

– to be able to acquire independently, comprehend, structure and use new gained knowledge and skills in professional activities, to develop innovative abilities;

– to be able to formulate research goals independently, establish a sequence steps for solving professional problems;

– to be able to apply knowledge of fundamental and applied disciplines that determine the focus (profile) of the master's program in practice;

– to be able to professionally choose and creatively use modern scientific and technical equipment for solving scientific and practical problems;

– to be able to critically analyze, represent, defend, discuss and disseminate the results of their professional activities;

– proficiency in the preparation and execution of scientific and technical documentation, scientific reports, reviews, reports and articles;

– willingness to lead a team in the field of their professional activities, tolerantly perceiving social, ethnic, confessional and cultural differences;

– capable of communication in oral and written forms in a foreign language to solve the problems of professional activity.

A graduate who has received Master's degree must have professional competencies corresponding to the types of professional activity that the Master's program is focused on:

scientific research activities:

– to form diagnostic solutions to professional problems by integrating the fundamental sections of science and specialized knowledge gained during the master's program;

– to conduct independently scientific experiments and research in the professional field, generalize and analyze experimental information, draw conclusions, formulate conclusions and recommendations;

– to create and explore models of objects under study based on the use of in-depth theoretical and practical knowledge in the field of functional materials;

scientific production activities:

– to carry out production and research and production field, laboratory and interpretation work in solving practical problems independently;

– to professionally operate modern field and laboratory equipment and instruments in the field of the master's program;

– to use modern methods of processing and interpreting complex information to solve production problems;

project activities:

– to compose and submit projects of research and development work independently;

– to design complex scientific research and scientific production work in solving professional problems;

organizational and management activities:

– to use the practical skills of organizing and managing research and development work in solving professional problems;

– to use the practical skills of organizing and managing research and development work in solving professional problems;

– to use the practical skills of organizing and managing research and development work in solving professional problems;

– to use of normative documents in the planning and organization of scientific and production work;

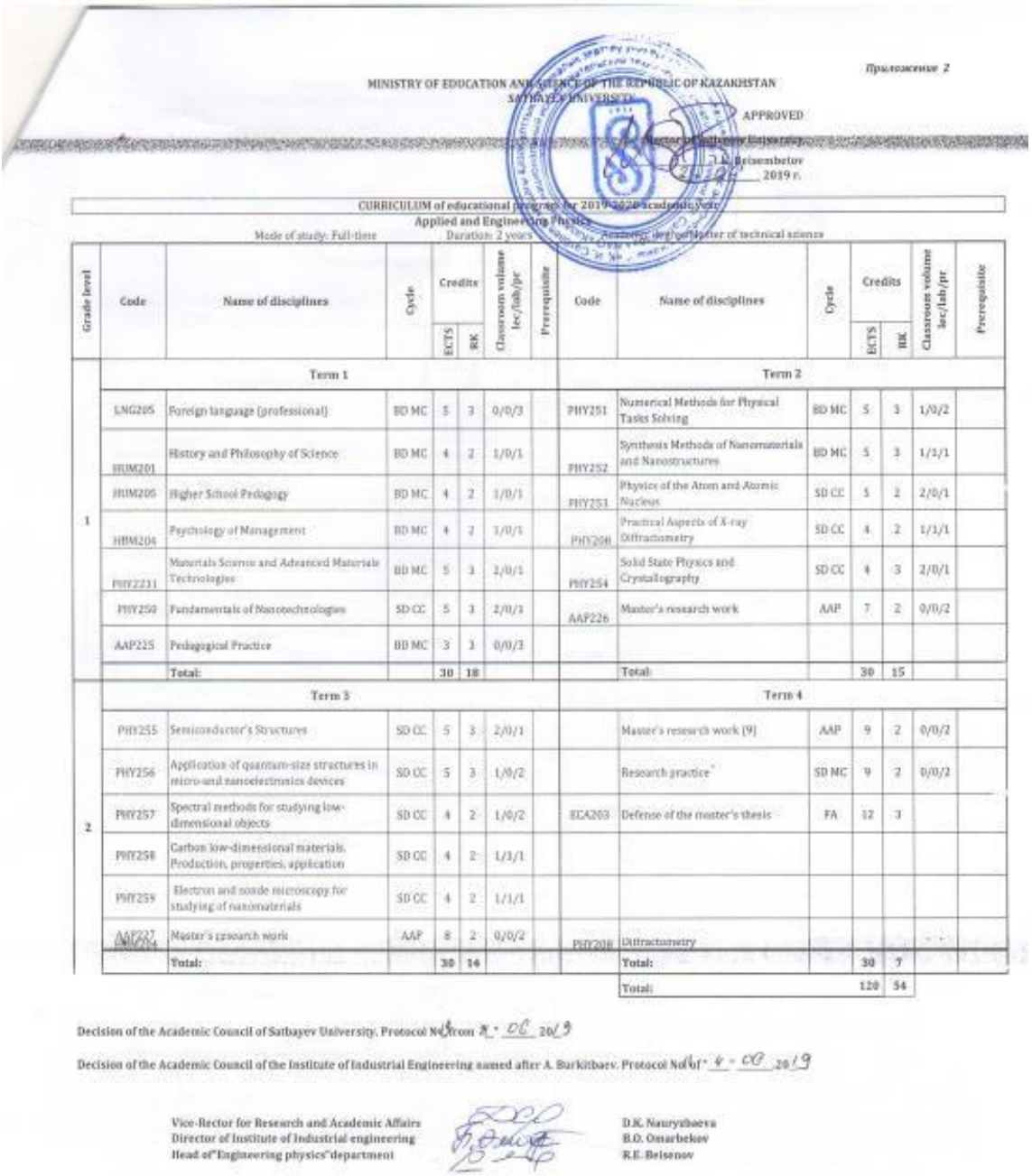
scientific and pedagogical activity:

– to conduct seminars, laboratory and practical exercises;

– to participate in the management of scientific and educational work of students in the field of functional materials.

All general cultural and general professional competencies, as well as professional competencies related to those types of professional activities that the Master's program is focused on, are included in the set of required results of completing the Master's program.

4. Working curriculum Academic degree:



Приложение 2

MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
SATBAYEV UNIVERSITY

APPROVED
Rector of Satbayev University
T.K. Beisembetov
"28" 08 2019 г.

CURRICULUM of educational program for 2019-2020 academic year
Applied and Engineering Physics
Mode of study: Full-time Duration: 2 years Awarding: degree Master of technical science

Grade level	Code	Name of disciplines	Cycle	Credits ECTS	Credits RK	Classroom volume lec/lab/pr	Prerequisite	Code	Name of disciplines	Cycle	Credits ECTS	Credits RK	Classroom volume lec/lab/pr	Prerequisite
1		Term 1							Term 2					
	LNG205	Foreign language (professional)	BD MC	5	3	0/0/3		PHY251	Numerical Methods for Physical Tasks Solving	BD MC	5	3	1/0/2	
	HUM201	History and Philosophy of Science	BD MC	4	2	1/0/1		PHY252	Synthesis Methods of Nanomaterials and Nanostructures	BD MC	5	3	1/1/1	
	HUM205	Higher School Pedagogy	BD MC	4	2	1/0/1		PHY253	Physics of the Atom and Atomic Nucleus	SD CC	5	2	2/0/1	
	HBM204	Psychology of Management	BD MC	4	2	1/0/1		PHY208	Practical Aspects of X-ray Diffractometry	SD CC	4	2	1/1/1	
	PHY2231	Materials Science and Advanced Materials Technologies	BD MC	5	3	2/0/1		PHY254	Solid State Physics and Crystallography	SD CC	4	3	2/0/1	
	PHY250	Fundamentals of Nanotechnologies	SD CC	5	3	2/0/1		AAP226	Master's research work	AAP	7	2	0/0/2	
	AAP225	Pedagogical Practice	BD MC	3	1	0/0/3								
		Total:		30	18				Total:		30	15		
2		Term 3							Term 4					
	PHY255	Semiconductor's Structures	SD CC	5	3	2/0/1			Master's research work (9)	AAP	9	2	0/0/2	
	PHY256	Application of quantum-size structures in micro-and nanoelectronics devices	SD CC	5	3	1/0/2			Research practice*	SD MC	9	2	0/0/2	
	PHY257	Spectral methods for studying low-dimensional objects	SD CC	4	2	1/0/2		ECA203	Defense of the master's thesis	FA	12	3		
	PHY258	Carbon low-dimensional materials. Production, properties, application	SD CC	4	2	1/1/1								
	PHY259	Electron and sonde microscopy for studying of nanomaterials	SD CC	4	2	1/1/1								
	AAP227	Master's research work	AAP	8	2	0/0/2		PHY208	Diffractometry					
		Total:		30	14				Total:		30	7		
									Total:		120	54		

Decision of the Academic Council of Satbayev University. Protocol №6 from "28" 08 2019

Decision of the Academic Council of the Institute of Industrial Engineering named after A. Burkitbaev. Protocol №1 "4" 09 2019

Vice-Rector for Research and Academic Affairs — D.K. Nauryzbaeva
Director of Institute of Industrial engineering — B.O. Omarbekov
Head of"Engineering physics"department — R.E. Beisenov

5 Descriptors of the level and amount of knowledge, abilities, skills and competencies

The requirements for the level of training of a Master's student are determined on the basis of the Dublin descriptors of the second level of higher education (Master's degree) and reflect the acquired competencies, expressed in the achieved learning outcomes.

Learning outcomes are formulated both at the level of the entire educational program of the Master's program, and at the level of individual modules or academic discipline.

Descriptors reflect learning outcomes that characterize the student's abilities:

1) to demonstrate evolving knowledge and understanding in the field of functional materials, based on advanced knowledge in applied and engineering physics, when developing and / or applying ideas in the context of research;

2) to apply at a professional level their knowledge, understanding and abilities to solve problems in a new environment, in a wider interdisciplinary context;

3) to collect and interpret information to form judgments, taking into account social, ethical and scientific considerations;

4) to communicate clearly and unambiguously information, ideas, findings, problems and solutions to both professionals and non-specialists;

5) to develop learning skills necessary for independent work in the field of applied and engineering physics.

6 Completion competencies

Requirements for the key competencies of graduates of the *scientific and pedagogical magistracy*:

1) to have an idea:

– about the role of science and education in public life;

– about current trends in the development of scientific knowledge;

– on topical methodological and philosophical problems of natural (social, humanitarian, economic) sciences;

– about professional competence of a higher school teacher;

– about contradictions and socio-economic consequences of globalization processes;

2) to know about:

– methodology of scientific knowledge;

– principles and structure of the organization of scientific activity;

– psychology of students' cognitive activity in the learning process;

– psychological methods and means of increasing the efficiency and quality of education;

3) to be able to:

– use the gained knowledge for innovative development and application of ideas in the context of scientific research;

– analyze critically the existing concepts, theories and approaches to the analysis of processes and phenomena

– integrate the gained knowledge in different disciplines to solve research problems in new unfamiliar conditions;

– make critical judgments and decisions based on incomplete or limited information by integrating knowledge;

– apply knowledge of pedagogy and psychology of higher education in their pedagogical activity;

– apply interactive teaching methods;

– carry out information-analytical and information-bibliographic work with the involvement of modern information technologies;

– think creatively and be creative in solving new problems and situations;

– be fluent in a foreign language at a professional level, allowing for research and teaching of special disciplines in universities;

– to summarize the results of research and analytical work in the form of a dissertation, scientific article, report, analytical note, etc

4) to have skills in:

– research activities, solving standard scientific problems;

– implementation of educational and pedagogical activities on credit technology of education;

– methods of teaching professional disciplines;

– the use of modern information technologies in the educational process;

– professional communication and intercultural communication;

– oratory, correct and logical formulation of your thoughts in oral and written form;

– expanding and deepen knowledge necessary for daily professional activities and to continue education in doctoral studies.

5) to be competent:

– in a field of research methodology;

– in a field of scientific and scientific-pedagogical activities in higher educational institutions;

– in matters of modern educational technologies;

– in an implementation of scientific projects and research in the professional field;

– in ways to ensure constant updating of knowledge, expansion of professional skills and abilities.

B – basic knowledge, abilities and skills

B1 – ability to represent logically the acquired knowledge, ability to understand basic concepts and definitions in the field of applied and engineering physics;

B2 – knowledge of approaches and methods of critical analysis, ability to use them in practice in solving theoretical and practical problems related to the synthesis and study of low-dimensional structures;

B3 – ability to present the results of the work performed in the form of reports, scientific publications, reports at scientific conferences using the modern possibilities of information technology and oratory.

P – professional competence:

P2 – ability to formulate tasks related to the implementation of professional functions;

P3 – demonstrate systemic knowledge for independent research and development on the creation, research and application of low-dimensional structures;

P4 – ability to analyze and understand the results of scientific research, search and analyze scientific and technical information in the field of engineering physics and related disciplines;

P5 – to assess the scientific significance and prospects for the applied use of research results carried out in the field of physics of functional materials;

P6 – be able to work in a team, correctly defend their point of view, propose new ways in solving problems related to synthesis technology, research and practical application of functional materials;

P7 – skills of daily acquisition of new knowledge necessary for the high-quality performance of their professional functions.

H - Human, social and ethical competences

H1 – understanding and practical use of the norms of a healthy lifestyle, including issues of prevention, ability to use physical culture to optimize performance;

H2 – to know the state, Russian and one of the common foreign languages at a level that ensures human communication;

H3 – awareness of the need and the acquisition of the ability to independently study and improve their qualifications during the entire labor activity.

S – Special and management competencies:

S1 – independent management and control of work processes within the framework of the strategy, policy and goals of the organization, discussion of the problem, reasoning conclusions and competent handling of information;

S2 – to know and own the main management functions (decision-making, organization, motivation, control) and methods of their implementation;

S3 – have organizational skills, be able to organize a group of specialists to fulfill the set goals and be able to manage such a group, be able to protect their rights and demand that they fulfill their duties.

Requirements for the research work of a Master student in a scientific and pedagogical magistracy:

1) corresponds to the profile of the Master's educational program, according to which the Master's thesis is carried out and defended;

2) relevant and contains scientific innovative and practical significance;

3) is based on modern theoretical, methodological and technological achievements of science and practice;

4) performed using modern scientific research methods;

5) contains research (methodological, practical) sections on the main protected provisions;

6) is based on international best practices in the relevant field of knowledge.

Requirements for organizing practices:

The educational program of the scientific and pedagogical magistracy includes two types of practices that are conducted in parallel with theoretical training or in a separate period:

1) pedagogical practice in the BD cycle - at the university;

2) research practice in the PS cycle - at the place of the dissertation.

Pedagogical practice is carried out with the aim of developing practical skills in teaching and learning methods. At the same time, undergraduates are involved in conducting classes in a Bachelor's degree at the discretion of the university.

The research practice of the undergraduate is carried out with the aim of acquainting with the latest theoretical, methodological and technological achievements of domestic and foreign science, modern methods of scientific research, processing and interpretation of experimental data.

7 ECTS Diploma Supplement

The application was developed according to the standards of the European Commission, Council of Europe and UNESCO / CEPES. This document is for academic recognition only and is not an official proof of education. Not valid without a university degree. The purpose of completing the European Supplement is to provide sufficient information about the holder of the diploma, the qualification obtained, the level of this qualification, the content of the study program, the results, the functional purpose of the qualification, as well as information about the national education system. The application model that will be used to translate grades uses the European Credit Transfer or Transfer System (ECTS).

The European Diploma Supplement provides an opportunity to continue education at foreign universities, as well as to confirm national higher education for foreign

employers. When going abroad for professional recognition, additional legalization of the educational diploma is required. The European Diploma Supplement is filled in English upon individual request and is issued free of charge.

Foreign language (professional)

Professional English for Project Managers CODE – LNG205
CREDITS – 5
PREREQUISITES – Academic English, Business English, IELTS 5.0-5.5

PURPOSE AND GOALS OF THE COURSE

The aim of the course is to develop students' knowledge of the English language for their ongoing academic research and to improve their performance in the field of project management.

SHORT DESCRIPTION OF THE COURSE

The course is aimed at building vocabulary and grammar for effective communication in project management and improving reading, writing, listening and speaking skills at the "Intermediate" level. Students are expected to develop their Business English vocabulary and learn grammar structures that are often used in a management context. The course consists of 6 modules. The 3rd module of the course ends with an intermediate test, and the 6th module is followed by a test at the end of the course. The course ends with a final exam. Master's students also need to study independently (MIS). MIS is an independent work of undergraduates under the guidance of a teacher.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE

Upon successful completion of the course, students are expected to be able to recognize the main message and message as well as specific details while listening to monologues, dialogues and group discussions in the context of business and management; understand written and spoken English on topics related to management; write management texts (reports, letters, emails, minutes of meetings), following a generally accepted structure with a higher degree of grammatical accuracy and using business words and phrases, talk about various business situations using appropriate business vocabulary and grammatical structures - in pairs and groups discussions, meetings and negotiations

History of philosophy and science

CODE – HUM201
CREDITS – 3
PREREQUISITES – HUM124 Philosophy

PURPOSE AND GOALS OF THE COURSE
To reveal the connection between philosophy and science, to highlight the philosophical problems of science and scientific knowledge, the main stages of the history of science the leading concepts of the philosophy of science, modern problems of the development of scientific and technical reality

SHORT DESCRIPTION OF THE COURSE
The subject of philosophy of science, dynamics of science, specificity of science, science and pre-science, antiquity and the formation of theoretical science, the main stages of the historical development of science, features of classical science, non-classical and post-non-classical science, philosophy of mathematics, physics, technology and technology, specificity of engineering sciences, ethics of science , social and moral responsibility of a scientist and engineer

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE
- to know and understand the philosophical issues of science, the main historical stages in the development of science, the leading concepts of the philosophy of science, be able to critically evaluate and analyze scientific and philosophical problems, understand the specifics of engineering science, possess the skills of analytical thinking and philosophical reflection, be able to substantiate and defend one's position, own methods of discussion and dialogue, possess the skills of communication and creativity in their professional activities.

Higher school pedagogy
CODE– HUM205
CREDITS – 4
PREREQUISITES – HUM12 PHILOSOPHY

PURPOSE AND GOALS OF THE COURSE
The course is aimed at studying the psychological and pedagogical essence of the educational process of higher education; formation of ideas about the main trends in the development of higher education at the present stage, consideration of the methodological foundations of the learning process in higher education, as well as psychological mechanisms affecting the success of learning, interaction, management of subjects of the educational process. Development of psychological and pedagogical thinking of undergraduates.

SHORT DESCRIPTION OF THE COURSE
In the scope of studying the course, undergraduates get acquainted with the didactics of higher education, the forms and methods of organizing education in higher education, the psychological factors of successful learning, the peculiarities of psychological influence, the mechanisms of educational influence, pedagogical technologies, characteristics of pedagogical communication, and mechanisms for managing the learning process. Analyze organizational conflicts and ways to resolve them, psychological destruction and deformation of the teacher's personality.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE
At the end of the course, the undergraduate must know the features of the modern system of higher professional education, the organization of pedagogical research, the characteristics of the subjects of the educational process, the didactic foundations of the organization of the learning process in higher education, pedagogical technologies, the patterns of pedagogical communication, the features of educational influences on students, as well as the problems of pedagogical activity.

Management psychology

CODE – HUM
CREDITS – 5
PREREQUISITES – none

PURPOSE AND GOALS OF THE COURSE
The purpose of this discipline is to form the foundations of pedagogical culture as the basic foundation for the further successful mastering by undergraduates of scientific and pedagogical knowledge, skills and values in the field of pedagogical science and practice. A specialist with a higher education, focused on future research and teaching activities, must be able to build and manage the pedagogical process, work in a group and with a group, build individual, didactically correct teaching and upbringing. These aspects necessitate the inclusion of the course "Pedagogy" in the curriculum of postgraduate training.
This course aims to give knowledge to undergraduates on the theory and methodology of teaching in higher education, to systematize ideas about the specifics of pedagogical activity, to master knowledge on the organization of the educational process and its management, the characteristics of individual mental development and personality formation.
KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
As a result of mastering the discipline, the Master's student must:
To know:
- the specifics of various areas of psychological and pedagogical activity: diagnostics, correction and development, teaching (education), prevention;
- methodological foundations for the development and planning of psychological and pedagogical classes;
- functional and organizational and legal foundations of the professional activity of a psychologist, depending on the type of institution;
Be able to:
- compose psychological and pedagogical characteristics of both the individual and the team on the basis of the research;
- use psychological methods of development and education of students, taking into account their age and individual characteristics;
- organize extra-curricular psychological and pedagogical activities aimed at personal development, optimization of the psychological climate of the team, support of the educational process, self-determination and professional orientation.
To acquire:

- skills of planning psychological and pedagogical activities (drawing up training programs, action plans, correctional and developmental programs);

- methods of psychological and pedagogical communication, both individually and with the audience, taking into account age, social and other characteristics;

- skills of joint project execution in a team of colleagues (fellow students);

- methods of active social and psychological learning (discussion, brainstorming, problem lecture, etc.);

- individual psychological techniques for increasing the motivational potential of students.

Materials Science and Advanced Materials Technologies

CODE – PHY2231
CREDITS – 5
PREREQUISITES – PHY122 Physical Materials Science, PHY245 Functional Materials

PURPOSE AND GOALS OF THE COURSE
To form a modern scientific understanding of the foundations of materials science and technology for creating promising materials.

SHORT DESCRIPTION OF THE COURSE
Materials science and technologies for obtaining promising materials based on low-dimensional objects are widely used for the development of devices and devices for optoelectronics, nanoelectronics, sensor devices and biosensors of a new generation; technologies for obtaining promising nanostructures, as well as their application are considered.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To develop skills and abilities of solving theoretical and experimental - practical problems related to materials science, as well as the technology of creating and using promising materials.

Fundamentals of nanotechnology

CODE –
CREDITS – 5
PREREQUISITES – PHY149 Quantum mechanics, PHY196 Condensed Matter Physics

PURPOSE AND GOALS OF THE COURSE
To study the methods of obtaining low-dimensional materials, their features, problems and advantages.

SHORT DESCRIPTION OF THE COURSE
The term "nanotechnology" refers to the creation and use of materials, devices and systems, the structure of which is regulated on a nanometer scale, i.e. in the range of sizes of atoms, molecules and supramolecular formations. Nanotechnology implies the ability to work with such objects and create from them larger structures with a fundamentally new molecular organization. Such structures, built "from first principles", using atomic molecular elements, are the smallest objects. The course examines the fundamental problems of modern technology.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To form the skills and abilities of solving theoretical and experimental - practical problems related to the production and research of low-dimensional materials.

Numerical Methods for Physical Tasks Solving

CODE – PHY
CREDITS – 5
PREREQUISITES – Physics I, Physics II, Physics III, Methods of theoretical physics

PURPOSE AND GOALS OF THE COURSE
To teach the construction of mathematical models of various physical phenomena, the study of the main methods for solving the mathematical problems arising in this case, the clarification of the physical meaning of the solutions obtained.

SHORT DESCRIPTION OF THE COURSE
Creating a mathematical model (drawing up equations describing the phenomenon under study). Selection of numerical calculation methods (construction of a discrete model approximating the original mathematical problem, construction of a difference scheme, development of a computational algorithm, etc.). Creation of a program that implements a computational algorithm. Calculations and processing of the information received. Analysis of the calculation results, comparison (if possible) with a field experiment.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To demonstrate the ability to apply the acquired knowledge in mathematics and physics to formulate, formulate and solve applied scientific technical problems using recognized methods of computational physics.

Synthesis Methods of Nanomaterials and Nanostructures

CODE – PHY
CREDITS – 5
PREREQUISITES – PHY149 Quantum Mechanics, PHY196 Condensed Matter Physics, PHY245 Functional Materials

PURPOSE AND GOALS OF THE COURSE
To reveal the essence of the processes of formation of low-dimensional structures, processes on the surface and in the near-surface layers.

SHORT DESCRIPTION OF THE COURSE
The discipline "Methods for obtaining functional materials and nanostructures" gives an idea of the synthesis and analysis of morphology, structure, chemical and phase composition of functional materials, allows you to acquire knowledge about chemical,about methods of controlled growth to obtain nanostructures required size and shape, about the methods of synthesis of films and coatings, massive nanostructured and microporous materials, about the stabilization of dispersions of nanoparticles and self-organization of nanostructures in films and bulk structures.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To form the skills and abilities of solving theoretical and experimental - practical problems, to analyze the advantages and disadvantages of various methods for obtaining nanoparticles and functional materials, to choose rational methods for the synthesis of low-dimensional objects and functional materials.

Physics of the Atom and Atomic Nucleus

CODE – PHY253
CREDITS – 5
PREREQUISITES – Physics I, Physics II, Physics III, PHY149 Quantum Mechanics

PURPOSE AND GOALS OF THE COURSE

The goals of mastering the discipline are the continuation and development of ideas about the quantum properties of microparticles, which allow, on their basis, to describe the structure and properties of the atom and atomic nucleus.

SHORT DESCRIPTION OF THE COURSE
The main goals of the discipline are: 1) to give students the knowledge on theoretical premises and experiments that made it possible to create a modern theory of the atom and atomic nucleus; 2) the acquisition of practical skills in the study of phenomena arising from the basic provisions of the theory of the structure of the atom and atomic nucleus

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To know: basic concepts, models, laws and theories from the course "Physics of atoms and atomic nucleus". **To be able to:** to apply the obtained theoretical basis for solving specific practical problems, competently work with scientific literature using new information technologies. **To acquire:** the main methods of scientific research, the skills of conducting a physical (laboratory) experiment, statistical processing of experimental data using modern information technologies.

Practical Aspects of X-ray Diffractometry

CODE – PHY
CREDITS – 5
PREREQUISITES – PHY196 Condensed Matter Physics, PHY131 Crystal Physics

PURPOSE AND GOALS OF THE COURSE
To form an idea about the applied methods of using X-ray diffraction to study the crystal structure of materials.

SHORT DESCRIPTION OF THE COURSE
To study the issues of materials research using X-rays, X-ray analysis of ordered solid solutions, X-ray radiation of residual distortions in metals and alloys, X-ray methods for determining stresses, various methods of X-ray microscopy, questions of the technical use of X-rays for detecting internal material defects (X-ray flaw detection) and X-ray topography.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To develop abilities and skills in solving standard and specific problems of X-ray spectroscopy, using research methods; the ability to apply theoretical knowledge in solving problems of applied X-ray spectroscopy.

Solid State Physics and Crystallography

CODE – PHY
CREDITS – 5
PREREQUISITES – Physics I, Physics II, Physics III

PURPOSE AND GOALS OF THE COURSE

The purpose of the discipline "Solid State Physics and Crystallography" is to give students an idea of the fundamental foundations of solid state physics and crystallography, about the features of the structure of crystals, about the role that symmetry plays in explaining the properties of solids, about the effect of defects on the properties of solids , to develop students' systemic understanding of the processes occurring in the materials of electronic means. The goals of the course is to teach students to independently acquire the necessary knowledge on the theoretical foundations of solid state physics and the basics of crystallography; modern approaches and methods used to analyze and describe the properties of solids; methods for calculating the main parameters of solids.

SHORT DESCRIPTION OF THE COURSE

The course forms students' ideas about the methods of theoretical description, calculation, qualitative and quantitative analysis of physical processes occurring in solids under the influence of external fields (electric and magnetic), mechanical and temperature effects, as well as optical radiation. As a result of studying the course, the student acquires fundamental knowledge about the basics of describing physical processes in solids, as well as the skills of solving and researching specific physical problems.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:

To know: - the system of concepts and ideas about various types of symmetry used to characterize the structure and properties of solids; - about the band structure of crystals, about quantum-statistical approaches to describing their properties; - the main types of defects in solids, on structural models used to describe defects and the effect of defects on the physical properties of crystals;

To be able to: - explain the main observed natural and man-made phenomena and effects from the standpoint of fundamental physical theories; - work with instruments and equipment of a modern physics laboratory; - to use various methods of physical

measurements and processing of experimental data; - determine the semiconductor band gap;

To acquire: - principles and methods of mathematical description of physical phenomena and processes, construction of their mathematical models; - skills in the correct operation of the main instruments and equipment of a modern physics laboratory; - methods of physical modeling in engineering practice.

Semiconductor's Structures

CODE –
CREDITS – 5
PREREQUISITES – PHY149 Quantum Mechanics, PHY196 Condensed Matter Physics

PURPOSE AND GOALS OF THE COURSE
To provide basic knowledge of the physics of semiconductor structures, necessary to understand the physical processes occurring in low-dimensional semiconductors.

SHORT DESCRIPTION OF THE COURSE
The main physical properties of low-dimensional semiconductor structures are considered: superlattices, quantum wells, threads, dots, the principles of dimensional quantization and the conditions for observing quantum-dimensional phenomena, as well as the features of the density of states function and statistics of charge carriers, optical properties and kinetic effects, including in magnetic fields. Examples of the practical use of such structures in modern electronics are presented.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To develop skills in the field of basic physical principles of construction and functioning of semiconductor systems, as well as the development, creation and application of special materials, devices and systems used in modern electronics.

Application of quantum-size structures in micro-and nanoelectronics devices

CODE – PHY
CREDITS – 5
PREREQUISITES – PHY149 Quantum mechanics, PHY245 Functional materials, Physico-chemical foundations of obtaining functional materials and nanostructures

PURPOSE AND GOALS OF THE COURSE
To form an idea of the technologies for obtaining materials used in micro-, opto- and nanoelectronic devices.

SHORT DESCRIPTION OF THE COURSE
Physic-chemical processes for obtaining materials used in micro-, opto- and nanoelectronics are considered, including the operation of separating a chemical individual from the feedstock, purification in the form of compounds, final refining, and obtaining single crystals with desired properties. The technologies for obtaining the main components of micro-, opto- and nanoelectronics: metals, alloying elements, dielectric materials, carbon materials, organometallic compounds and auxiliary materials are presented.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To acquire theoretical and practical skills in obtaining materials used in micro-, opto- and nanoelectronic devices.

Spectral methods for studying low-dimensional objects

CODE – PHY
CREDITS – 5
PREREQUISITES – PHY149 Quantum mechanics, PHY245 Functional materials

PURPOSE AND GOALS OF THE COURSE
To form a modern scientific understanding of the spectral methods of studying low-dimensional objects, their features and conditions of use among undergraduates.

SHORT DESCRIPTION OF THE COURSE
The analytical capabilities of mass spectrometric (MS) 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 FTIR spectrometry for studying the properties of low-dimensional objects are considered.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
To acquire theoretical and practical skills of working with spectrometric equipment for the study of low-dimensional objects.

Carbon low-dimensional materials. Production, properties,

CODE – PHY
CREDITS – 5
PREREQUISITES – PHY149 Quantum mechanics, PHY245 Functional materials

PURPOSE AND GOALS OF THE COURSE
The purpose of the discipline is to master the fundamentals of theoretical knowledge in the field of technologies of carbon materials and composites, their physical and chemical properties, and their application in various fields of the national economy.

SHORT DESCRIPTION OF THE COURSE
The course is devoted to modern carbon materials, their properties, production technologies and application possibilities. The main goals of the discipline: 1. Formation of ideas about the methods of synthesis of carbon materials. 2. Study of the basic physical and chemical properties of carbon materials and composites responsible for their operational and technological properties. 3. Establishing the relationship between the structure and properties of carbon materials.

KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
As a result of mastering the discipline, the student must demonstrate knowledge, skills and abilities corresponding to the modules of the discipline, and applicable in their subsequent education and professional activities: **To know**: 1. Methods of synthesis of carbon materials. 2. The main physical and chemical properties of carbon materials and composites responsible for their operational and technological properties. 3. The relationship between the structure and properties of carbon materials. **To be able to:** 1. use mathematical models of processes; 2. apply the foundations of theory in practice; 3. carry out theoretical research, to use reference and special literature in the field of chemical technology. To acquire: 1. Methods of obtaining and research methods of carbon materials; 2. Skills in calculating and determining the technological indicators of the process.

Study of functional materials by electron and probe microscopy

CODE –
CREDITS – 5
PREREQUISITES – PHY149 Quantum mechanics, PHY196 Condensed Matter Physics, Fundamentals of nanotechnology

---

PURPOSE AND GOALS OF THE COURSE
To form an ideas about physics, technology and the possibilities of electron and probe microscopy in the study of nanostructured materials.

SHORT DESCRIPTION OF THE COURSE
The main goals of the course are to provide the basic information about transmission electron and probe atomic force microscopy: the device and the main characteristics of devices, the theory of formation and interpretation of the images obtained, to form theoretical and practical skills in working with transmission electron and probe atomic force microscopes. Electron and scanning probe microscopy are one of the main methods for analyzing and modifying the surface of a sample and a substrate, which are widely used in the field of physics of functional materials, in scientific research of the physical and chemical properties of objects with high spatial resolution.
KNOWLEDGE, ABILITY, SKILLS AFTER COMPLETION OF THE COURSE:
the skills and abilities of conducting experimental research using electron and probe microscopy methods and processing the results will be formed.

Master's student scientific research, including an internship and a master's thesis.

CODE – NIRM
CREDITS – 24

PURPOSE AND GOALS OF THE COURSE

The purpose of the research work of the Master's student, including the internship and the implementation of the master's thesis, is to develop the ability to independently carry out research work related to solving complex professional problems on the topic of dissertation work.

SHORT DESCRIPTION OF THE COURSE

The tasks of the research work are: ensuring the formation of professional scientific research thinking of undergraduates, the formation of a clear idea of the main professional tasks, ways of solving them; formation of skills to use modern technologies for collecting information, processing and interpreting obtained experimental and empirical data, possession of modern research methods; ensuring readiness for professional self-improvement, the development of innovative thinking and creative potential, professional skills; carrying out bibliographic work using modern information technologies.

Teaching (Pedagogical) practice

CODE – PedPr
CREDITS – 7

PURPOSE AND GOALS OF THE COURSE
The purpose of teaching practice is: studying the basics of pedagogical and educational-methodical work in higher educational institutions, mastering the pedagogical skills of conducting certain types of training in disciplines of the profile corresponding to the direction of study.

SHORT DESCRIPTION OF THE COURSE:
Pedagogical practice is a type of practical activity of undergraduates, which includes teaching general disciplines, organizing students' educational activities, scientific and methodological work on the subject, obtaining skills and abilities in the work of a teacher. The organizer of the teaching practice is the base department, in the corresponding direction of the educational program. The supervisor of the student's pedagogical practice is the scientific supervisor.

Research practice
CODE – IslPr
CREDITS – 4

Purpose of research practice is to deepen and consolidating undergraduates' knowledge, skills and abilities acquired in the course of mastering the disciplines of vocational training by focusing on the main areas of scientific research corresponding to the topic of the dissertation work.

SHORT DESCRIPTION: Research practice refers to industrial practices and it is a practice to obtain professional skills and professional experience.

Registration and defense of Master's thesis

CODE – ECA501
CREDITS –12

The purpose of completing a master's thesis is demonstration of the level of scientific / research qualifications of a master student, the ability to independently conduct scientific research, test the ability to solve specific scientific and practical problems, knowledge of the most general methods and techniques for their solution.

SHORT DESCRIPTION

Master's thesis is a final qualifying scientific work, which is a generalization of the results of an independent study by a Master's student of one of the urgent problems of a specific specialty of the corresponding branch of science, which has internal unity and reflects the course and results of the development of the chosen topic.

The defense of the Master's thesis is the final stage of the Master's degree. Master's thesis must meet the following requirements:

- work should be based on the definition of important scientific problems and their solution;
- decisions must be scientifically grounded and reliable, have internal unity;
- the thesis should be written individually.

Content