1. OPTIONAL COMPONENTS OF THE CYCLE OF CORE COURSES

Optional component 1

Course: **Methods of control and evaluation on physical education**

Intensity of the Course: 5 academic credits

Module Code: ITTPh-2

Module Name: Innovative technologies for teaching physics

Prerequisites: CAT 3214 Criteria Assessment Technology

Purpose: Improving the quality of education. Achieving an objective assessment. The use ofmodern methods for evaluating learning outcomes.

Short Description: The place of control and evaluation in the system of specialized education, the knowledge assessment system, the assessment result, modern methods of evaluating learning outcomes, the use of other interactive online services on the Internet, such as Quizlet, Quizziz, Letstest. The skills of using modern methods of organizing designing and evaluating the results of subject-based learning are formed

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 4 - The introduction of modern educational methods and technologies in pedagogical activity, including for the diagnosis and assessment of the quality of the educational process;

LOP 5 - Implements methodological models, techniques, technologies and teaching methods;

Learning Outcomes in Course (LOC):

LOC 1 - Bringing education in line with international standards, improving the quality of education;

LOC 2 - Has the basic knowledge and skills to implement the pedagogical process in the updated system;

LOC 3 - Has the skills of organizing and conducting the pedagogical process using distance learning technology;

LOC 4 - Demonstrates knowledge of the conceptual and theoretical foundations of physics, the influence of physics on the development of engineering and technology, the relationship of physics with other sciences and their role in solving scientific and technical problems.

LOC 5 - Interpretation of theoretical and practical knowledge on the subject of pedagogical professional activity. Interpretation of the main theoretical and experimental materials with examples;

LOC 6 - Analysis of the innovative development of physics and modern physics.

Post requisites: PP Pedagogical practice.

Optional component 1

Course: **CLIL method in teaching physics**

Intensity of the Course: 5 academic credits

Module Code: ITTPh-2

Module Name: Innovative technologies for teaching physics

Prerequisites: MTPh 3302 Methodology of teaching physics

Purpose: Preparation of University undergraduates for professional and pedagogical activity of a physics teacher, determination of ways to implement didactic principles, pedagogical regularities of the organization of the educational process in Higher education in accordance with modern requirements.

Short Description: Master student studying English, assesses today's global technological breakthrough of the Fourth Industrial Revolution. A review and generalization of the results of using the CLIL methodology of subject-language integrated teaching in teaching is conducted, and a range of

possibilities for its integration in the system of multilevel education of physicists is identified in order to achieve a new quality of teacher training

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

Learning Outcomes in Course (LOC):

LOC 1 – to form a broad understanding of the modern physical picture of the world, which will reflect the latest scientific discoveries and hypotheses describing, explaining and predicting the behavior of physical systems in the microcosm, macrocosm and megamir;

LOC 2 – to increase the level of scientific training of undergraduates and their readiness to conduct classes with students that help stimulate their interest in natural Sciences;

LOC 3 – create an emotional background that increases interest in teaching physics for both undergraduates and their future students

Post requisites: PP Pedagogical practice.

Optional component 2

Course: **Workshop on solving complex physical problems 1**

Intensity of the Course: 5 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: BPSP 1 2211 Bases of problem solving on physics 1, BPSP 2 2211 Bases of problem solving on physics 2

Purpose: Training of highly qualified specialists who are able to effectively use the theoretical knowledge gained in the course of physics to solve practical problems

Short Description: Studies the theoretical foundations of methods for solving multi-level physical problems. Structure and classification of tasks. Technology for solving problems in physics. Problem analysis and a generalized method for solving problems (using the example of mechanics). Methods for solving computational problems in molecular physics and thermodynamics. Methods for solving graphical problems in molecular physics and thermodynamics

Learning Outcomes in EP (LOP):

LOP 5 - Implements methodological models, techniques, technologies and teaching methods;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems.

Learning Outcomes in Course (LOC):

LOC 1 – to master various methods of solving problems: analytical, graphical, experimental, etc.;

LOC 2 – To develop students ' logical thinking and interest in physics;

LOC 3 – Develop skills of independent work and self-study;

LOC 4 – consistently perform and pronounce the stages of solving a problem of medium difficulty; solve combined tasks;

LOC 5 – development of cognitive activity, creative and communicative abilities, memory, oral and written speech, intellectual and organizational planning skills, interest in the subject being studied, the ability to apply the acquired knowledge in practice;

LOC 6 – self-control and evaluation of the results of their activities; development of competence in the field of independent cognitive activity.

Post requisites: PP Pedagogical practice.

Optional component 2

Course: **Synergetic basis of control and assessment of knowledge quality**

Intensity of the Course: 5 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: MTPh 3302 Methodology of teaching physics, CAT 3214 Criteria Assessment Technology

Purpose: Acquaintance of undergraduates with a new scientific - static system of monitoring and evaluation of educational activities.

Short Description: Types, forms and organization of the assessment of learning outcomes. Essence, functions and requirements for quality control of training. Stages of development of a five-point grading scale. Types, forms and methods of control. The evaluation functions and the disadvantages of the traditional five-point assessment. Modern means of evaluating learning outcomes. Rating control system as an integral part of the educational process. Conditions for organizing a rating system and its advantages. Stages of designing a rating control system. Testing as a means of assessing learning outcomes. Psychological aspects of testing. Portfolio as one of the means of cumulative assessment of learning outcomes.

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 4 - The introduction of modern educational methods and technologies in pedagogical activity, including for the diagnosis and assessment of the quality of the educational process;

LOP 5 - Implements methodological models, techniques, technologies and teaching methods;

Learning Outcomes in Course (LOC):

LOC 1 – undergraduates should know the new multi-point scientific - static methods, control systems and evaluation of educational activities.

LOC 2 – to be able and have the skills to apply these methods of control and assessment of knowledge in their professional activities.

Post requisites: PP Pedagogical practice

Optional component 3

Course: **Planning and organization of scientific research**

Intensity of the Course: 5 academic credits

Module Code: ITTPh-2

Module Name: Innovative technologies for teaching physics

Prerequisites: FSR 3212 Fundamentals of scientific research

Purpose: formation of a system of basic knowledge and skills for the organization and conduct of scientific research in future specialists. Systematization, expansion and consolidation of professional knowledge, formation of undergraduates skills in conducting independent scientific work, research and experimentation.

Short Description: The discipline "Planning and organization of scientific research" considers the features of the development of science in the twenty-first century: priority areas of science in the Republic of Kazakhstan and abroad (in Japan, Europe, USA, China, Russia and other countries), planning and organization of scientific research, and processing of experimental data

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems.

Learning Outcomes in Course (LOC):

LOC 1 –Understands the role of scientific research in the development of the individual and the organization of education;

LOC 2 – Knows the principles and laws of methodology and technology for conducting scientific research and scientific forums;

LOC 3 – conducts research work in the organization of education;

LOC 4 – writes and presents scientific publications on the topic of scientific research.

LOC 5 – adapts innovative technologies, methods and tools, principles and patterns in selected areas of biology and teaching natural science subjects.

LOC 6 – projects methodological achievements and current problems of biology using modern methods of scientific research, processing and interpretation of experimental data.

Post requisites: MSR 7202 Methods of scientific research

Optional component 3

Course: **Actual problems of modern physics**

Intensity of the Course: 5 academic credits

Module Code: ITTPh-2

Module Name: Innovative technologies for teaching physics

Prerequisites: BMP 3215 The beginnings of modern physics

Purpose: To acquaint undergraduates with the main directions of development of physical science and important stages of its evolution, explaining the unified image of the world.

Short Description: Physics on the background of standard divinations about the end of science. Dialogue between physics and nature: the main stages and the modern methodology of cognition. Cognitive principles in the physics of the 21st century. Physics of the processes of evolution. Cosmological hypothesis of a singular event. Modern physics and the ideas of "reserve" evolution. Physics and axiomatic theory of substantial carriers. Physics of nanoscale structures, processes, complex systems. The problem of constructing new knowledge in modern physics

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1 – understands the role of the fundamental laws of physics and the most important areas of development of modern scientific industries.

LOC 2 – learn to conduct scientific and methodological analysis of the physical characteristics of systems and give them physical explanations.

LOC 3 – develops new current scientific directions and the main achievements of physics, and their application in science and technology.

Post requisites: ITPhEScR 7302 Innovative technologies in physical education and scientific research

2. OPTIONAL COMPONENTS OF THE CYCLE OF MAJOR COURSES

Optional component 1

Course: **Teaching physics using digital resources**

Intensity of the Course: 5 academic credits

Module Code: ITTPh-2

Module Name: Innovative technologies for teaching physics

Prerequisites: DTE 2208 Digital Technologies in Education

Purpose: Ensuring the high quality of education and the formation of a person who can actively use digital educational resources in the process of teaching physics.

Short Description: Develops the research of the modern innovative and technological direction in the field of e-education. He knows the methodological basics of working with ICT. Explores the possibilities of digital resources and how to use digital platforms in the learning process

Learning Outcomes in EP (LOP):

LOP 5 - Implements methodological models, techniques, technologies and teaching methods;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1-awareness of the value and role of digital culture, its impact on the formation of the future specialist;

LOC 2-ensure that the use of digital resources does not harm our national values;

LOC 3-knowledge of digitalization skills and the basics of distance learning in physics teaching;

LOC 4-analysis of phenomena and concepts in the teaching of physics using digital resources;

LOC 5-the ability to interact interactively during laboratory work;

LOC 6-the study of spatial forms and the formation of such abilities as the development of spatial imagination, critical thinking, the ability to make informed conclusions, solve problems and make decisions, responsibility.

Post requisites: ITPhEScR 7302 Innovative technologies in physical education and scientific research

Optional component 1

*Course**:*** **Physical foundations of ecology**

Intensity of the Course: 5 academic credits

Module Code: ITTPh-2

Module Name: Innovative technologies for teaching physics

Prerequisites: General physics course

Purpose: Greening the content of the physics discipline and studying the physical aspects of environmental education, forming the basis of environmental thinking and environmental morality for future teachers.

Short Description: Considers the pedagogical foundations of environmental education in the process of teaching physics. The use of modern techniques and technology in the organization and implementation of the educational process at various educational levels. Physical factors of environmentalpollution. The formation of environmental knowledge among students and the importance of environmental well-being in human life. Environment and nature conservation

Learning Outcomes in EP (LOP):

LOP 4 - The introduction of modern educational methods and technologies in pedagogical activity, including for the diagnosis and assessment of the quality of the educational process;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1 – Knowledge of basic environmental phenomena and ideas.

LOC 2 – Environmental and nature protection;

LOC 3 – Mastering the physical foundations of environmental pollution;

LOC 4 – Modeling of Environmental phenomena

LOC 5 – forming the foundations of ecological thinking and culture

LOC 6 – Origins of environmental problems

Post requisites: not

Optional component 2

Course: **Workshop on solving complex physical problems 2**

Intensity of the Course: 5 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: BPSP 1 2211 Bases of problem solving on physics 1, BPSP 2 2211 Bases of problem solving on physics 2, MSCSPPh 3303 Methodology of solving complex and structured problems in physics

Purpose: Training of highly qualified specialists who are able to effectively use the theoretical knowledge gained in the course of physics to solve practical problems

Short Description: When solving problems in the course program, it focuses on the analysis of a physical phenomenon, the oral presentation of the solution, and the features of the analysis of the received answer. The first classes are devoted to the methods of solving problems in the sections of general physics, electricity and magnetism, optics and atomic physics, the following sections discuss the methods of solving complex problems, i.e. problems of interdisciplinary content, the methods of solving Olympiadproblems

Learning Outcomes in EP (LOP):

LOP 5 - Implements methodological models, techniques, technologies and teaching methods;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems

Learning Outcomes in Course (LOC):

LOC 1 – to master various methods of solving problems: analytical, graphical, experimental, etc.;

LOC 2 – To develop students ' logical thinking and interest in physics;

LOC 3 – Develop skills of independent work and self-study;

LOC 4 – consistently perform and pronounce the stages of solving a problem of medium difficulty; solve combined tasks;

LOC 5 – development of cognitive activity, creative and communicative abilities, memory, oral and written speech, intellectual and organizational planning skills, interest in the subject being studied, the ability to apply the acquired knowledge in practice;

LOC 6 – self-control and evaluation of the results of their activities; development of competence in the field of independent cognitive activity.

Post requisites: PP Pedagogical practice.

Optional component 2

Course: **Project technology for teaching physics**

Intensity of the Course: 5 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: POSR 5207 Planning and organization of scientific research

Purpose: it is the development of master's students' methods of planning, organizing and implementing scientific research in the educational process and production.

Short Description: According to the sections of physics, before performing virtual-interactive laboratory (VIL) work, it is necessary to carry out design work, which includes designing all kinds of physical measuring instruments, the accuracy of their measurement on computer models, selecting software with an algorithm embedded in these devices, designing a visualization model hard-to- understand physics processes and designing laboratory work scenarios on a computer. Designing

visualization of multimedia support for a lesson in physics on particularly complex topics for understanding, designing a process model. An important part of physics design technology is the development of research projects. Design of scientific research, the necessary measuring equipment, financial resources, publications, copyright patents. Based on this lecture course, undergraduates will master the design technology in teaching and research of the named sections of physics

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills;

LOP 8 - Uses modern computer technology in his professional activities, including in modeling and visualization of complex physical phenomena and processes.

Learning Outcomes in Course (LOC):

LOC 1 –Undergraduates will learn how to analyze research methods and process the results of scientific research.

LOC 2 – can conduct patent search and knows the legal basis for intellectual property protection.

LOC 3 – is able to use modern methods (analytical, empirical and semi-empirical) when conducting scientific research.

LOC 4 – can analyze the levels of development of science in countries around the world.

Post requisites: MSR 7202 Methods of scientific research

Optional component 3

Course: **Alternative Energy Sources**

Intensity of the Course: 5 academic credits

Module Code: FMPhN-4

Module Name: Fundamentals of modern physics and Nanophysics

Prerequisites: MPhTh 2204 Molecular physics and thermodynamics

Purpose: The purpose of training future Bachelors with alternative energy sources is to stimulate their activities for the development of this direction of technology and technology.

Short Description: During the course, the undergraduate studies the current state of the use of renewable energy resources, problems and prospects for the development of these areas of energy; principle of operation and design of the implementation of the main elements of energy conversion devices; technical and economic indicators of renewable and alternative energy source

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1 – have an understanding of the technical and economic indicators of renewable sources and their ecology

LOC 2 – know about calculation methods in the field of energy conservation

LOC 3 – know the technology of energy production based on renewable energy sources and the program for the development of non-traditional energy in Kazakhstan

LOC 4 – use modern achievements of science and technology.

Post requisites: not

Optional component 3

Course: **Selected chapters of Thermo physics**

Intensity of the Course: 5 academic credits

Module Code: FMPhN-4

Module Name: Fundamentals of modern physics and Nanophysics

Prerequisites: Meh 1201 Mechanics, MPhTh 2204 Molecular physics and thermodynamics

Purpose: to acquaint students with the main problems of modern thermal physics, with the thermophysical processes of special production and to prepare students for the study of special courses, the calculation of projects and the implementation of individual special practical work.

Short Description: hermodynamics: mixtures of working fluids, heat capacity, laws of thermodynamics, thermodynamic processes and cycles, real gases and vapors, thermodynamics of flows, thermodynamic analysis of heat engineering devices, phase transitions, chemical thermodynamics. Cycles of heat power plants. Heat transfer theory: heat conduction, convection, radiation, heat transfer, heat transfer intensification. The basics of mass transfer. Heat and mass transfer devices. Basics of calculating heat exchangers. Fuel and combustion basics. Heat generating devices, refrigeration and cryogenic equipment. The use of heat in the industry. Environmental protection. The basics of energy conservation. Secondary energy resources. The main directions of energy saving

Learning Outcomes in EP (LOP):

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC1 – Knows selected chapters of Thermophysics and laws of thermodynamics;

LOC 2 – Calculates the equation of processes, equations of state, energy characteristics, the content of work and heat during heat transfer;

LOC 3 – Determines the thermophysical properties of various substances and the energy characteristics of thermodynamic processes;

LOC 4 – defines the place of Thermophysics in the technique of modern physics.

Post requisites: not

Optional component 4

Course: **Condensed matter physics**

Intensity of the Course: 5 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: Mech 1201 Mechanics, MPh 1202 Molecular physics and thermodynamics, BQM 3209 Bases of quantum mechanics.

Aim of the course: the acquisition by students of knowledge about the physical properties of crystalline solids, familiarization with the processes and phenomena occurring between atoms during condensation into a solid state.

Short Description: Since the theoretical and experimental apparatus of condensed matter physics is used in chemistry, materials science, engineering, nanotechnology, atomic physics, nuclear physics, and even in biophysics, this discipline is the most actively developing field of physics. Discipline gives undergraduates knowledge about a large number of interacting particles with strong bonds. Discipline is built in the following sequence of chapters of condensed matter physics: structural units of substances, physical and chemical foundations of particle bonds, interactions of particles, liquids and solids, various directions and applications of condensed matter physics. In turn, each of these chapters consists of many topics and subtopics that reveal the essence of modern condensed matter physics

Learning Outcomes in EP (LOP):

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1 - Knows the basics of the theory of the condensed state and the crystal lattice and its main sections, the history of its development and data related to the theory of modeling;

LOC 2 - Possess the skills of solving differential equations of the grid model and apply the basic basic methods of solving problems;

LOC 3 - Is able to see the difficulties that arise during liquid-crystal transitions, analyze and use various methodological techniques necessary for mastering the course material.

LOC 4 - A master's student knows what results should be achieved when studying the discipline and has knowledge in close contact with the results necessary for teaching physics to schoolchildren.

Post requisites: not

Optional component 4

Course: **Quantum field theory**

Intensity of the Course: 5 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: FQM 3304 Fundamentals of quantum mechanics

Aim of the course: quantum field theory describing the laws of motion and interactions of micro particles, taking into account fields, gravitational, electromagnetic.

Short Description: During the study of the discipline, graduates will become familiar with the quantum theory of free fields. The concept of wave fields and transformation properties of wave functions is considered. In this subject, undergraduates study the main types of fields: scalars, vectors, spinors. The concept of the Lagrangian of free fields is being formed

Learning Outcomes in EP (LOP):

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1 – know quantum fields, their main features, norms and physical characteristics of the gravitational field, features of the gravitational field, and basic field equations;

LOC 2 – substantiation of the theorems considered in the program, obtaining the use of theproposed literature, presentation of physical concepts, application in theoretical computer science, logical program, etc.

LOC 3 – the ability to argue physical formulas in the implementation of certain principles for the quantum field.

Post requisites: not

Optional component 5

Course: **Interactive visualization in teaching physics**

Intensity of the Course: 6 academic credits

Module Code: FMPhN-4

Module Name: Fundamentals of modern physics and Nanophysics

Prerequisites: RME 3301 Robotics and mechatronics in education

Aim of the course: the master students master the planning, organization and implementation of scientific research in the educational process and production.

Short Description: When teaching a physics course in all sections, to improve the quality of training and a deep understanding of the process, interactive visualization on the topics of each section is very effective. Visualization helps a good understanding of the process, and interactive intervention in the process, changing the parameters of functional dependence, very well helps to master the material and develops research skills. Therefore, combining visualization with interactiveization, computer-generated virtual interactive laboratory work is created in the following sections: Mechanics, Molecular Physics and Thermodynamics, Electricity and Magnetism, Optics. Undergraduates in the lecture course will fully get acquainted with the interactive visualization of processes on various topics in the above sections of physics

Learning Outcomes in EP (LOP):

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills;

LOP 8 - Uses modern computer technology in his professional activities, including in modeling and visualization of complex physical phenomena and processes.

Learning Outcomes in Course (LOC):

LOC 1 – knows how to conduct patent search and legal framework for the protection of intellectual property.

LOC 2 – knows the priorities in the leading scientific centers of the world and the Republic of Kazakhstan.

LOC 3 – master modern methods (analytical, empirical, and semi-empirical) when conducting scientific research.

Post requisites: not

Optional component 5

Course: **Numerical methods in physics**

Intensity of the Course: 6 academic credits

Module Code: FMPhN-4

Module Name: Fundamentals of modern physics and Nanophysics

Prerequisites: ANT 2206 Algebra and number theory

Aim of the course: formation of systematic knowledge in the field of numerical methods for solving problems of mathematical analysis, algebra and mathematical physics on a computer.

Short Description: The course "Numerical methods in physics" is aimed at mastering knowledge and practical skills on the formulation of a physical problem and finding the most effective numerical solution to this problem. The following topics will be studied in this course: Numerical methods in physics: basic concepts, problem statement. Approximation of functions. Interpolation of functions.Selection of empirical formulas. Linear and quadratic interpolation. Approximation of functions. Approximation of functions. Least square method. Methods of numerical integration. Methods of rectangles, trapezoid. The Simpson Method. Monte Carlo Method. Numerical solution of various integral and differential equations describing a physical phenomenon or process

Learning Outcomes in EP (LOP):

LOP 5 - Implements methodological models, techniques, technologies and teaching methods;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1 – technologies for applying computational methods to solve specific problems from various fields of mathematics and its applications;

LOC 2 – skills of practical evaluation of the accuracy of results obtained in the course of solving certain computational problems, based on the approximation theory;

LOC 3 – the main methods of using computational methods in solving various problems of professional activity.

Post requisites: not

Optional component 6

Course: **Methods of in-depth study of the General physics course**

Intensity of the Course: 6 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: MTPh 3302 Methodology of teaching physics, TSchPhE 3303 Technology of school physical experiment

Purpose: to deepen the theoretical aspects of the General physics course, to develop effective methods of teaching the General physics course and to master students.

Short Description: The content of the discipline reveals the features of studying the most important section of physics, special attention is paid to the most difficult, but methodologically and practically important issues that are not sufficiently represented in school practice. The principles of selection of educational material, construction of teaching methods are discussed, methodological approaches to teaching problem solving in separate sections of physics are considered

Learning Outcomes in EP (LOP):

LOP 4 - The introduction of modern educational methods and technologies in pedagogical activity, including for the diagnosis and assessment of the quality of the educational process;

LOP 5 - Implements methodological models, techniques, technologies and teaching methods;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems.

Learning Outcomes in Course (LOC):

LOC 1 – in physics lessons, constantly develop students ' interest and activity in the subject.

LOC 2 – Proper organization and management of the process of obtaining and mastering knowledge to improve the quality of training

LOC 3 – develop physical thought in students, form a physical worldview, familiarize them with the basics and methods of physics,

LOC 4 – teach the principles and laws of physics to solve both simple and non-generalized physical problems

LOC 5 – development of students ' perseverance and hard work in combination with education

Post requisites: MFDTPhSch 7203 Methodological foundations of differentiated teaching of physics at school, DTPhHSSch7302 Didactics of teaching physics in higher and secondary schools

Optional component 6

Course: **Physics and its methodological foundations**

Intensity of the Course: 6 academic credits

Module Code: SCPh-3

Module Name: Special chapters of physics

Prerequisites: MTPh 3302 Methodology of teaching physics, TSchPhE 3303 Technology of school physical experiment

Purpose: Presentation of effective methods of teaching physics and mastering students, theoretical justification, methodological support for training future physics teachers to study the physics course

Short Description: This course examines the theory of relativity. The problem of the world aether; Special theory of relativity; The role of the general theory of relativity in understanding the fundamental problems associated with space and time. About quantum physics, as the theoretical basis of scientific and technological progress. Schrödinger equation. Wave function. The ratio of uncertainties and the consequence of it. About laser physics. The fundamental nature of probability laws. From dynamic physical theories to static. The laws of conservation and probability. Order from chaos. Theory of self- organization. Synergetics. Dialectic of necessary and random. What is symmetry? Symmetry of physical laws and laws of conservation. The principle of conformity and the dialectic of the process of knowledge. The principle of conformity in quantum mechanics. The development of physics and the principle of conformity

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 4 - The introduction of modern educational methods and technologies in pedagogical activity, including for the diagnosis and assessment of the quality of the educational process;

LOP 5 - Implements methodological models, techniques, technologies and teaching methods.

Learning Outcomes in Course (LOC):

LOC 1-actively adjusts the educational process, the student learns the methods of independent learning;

LOC 2-owns methods and methods for determining the main, basic value of physical processes;

LOC 3-formation of students ' stable cognitive interest in the subject of physics;

LOC 4-Use of problem situations with the transfer of material in a problematic way.

LOC 5-Use of innovative (multimedia, information, communication) teaching methods.

Post requisites: MFDTPhSch 7203 Methodological foundations of differentiated teaching of physics at school, DTPhHSSch7302 Didactics of teaching physics in higher and secondary schools

Optional component 7

Course: **Physical crystallography and fundamentals of nanotechnology**

Intensity of the Course: 6 academic credits

Module Code: FMPhN-4

Module Name: Fundamentals of modern physics and Nanophysics

Prerequisites: PS 4308 Physics of solids

Aim of the course: Nano-science is one of the most promising directions in the development of science and technology. Science not only promises to be a generator of new technological methods, but also a disaster is always in competition.

Short Description: During the study of the discipline the following are considered: Basic concepts of nanosystems and the history of its occurrence. Examples of nano-objects and their features, as well as technological applications. The role of volume and surface on physical properties is studied. Mechanics of nanoobjects. Friction force. Coulomb interaction. The forces of Van der Waals. Undergraduates will become familiar with the instruments and methods: Electron Microscopy (TEM and SEM). Electron spectroscopy. Scanning probe microscopy: Force microscopy. Spectroscopy of atomic force interactions

Learning Outcomes in EP (LOP):

LOP 3 - Applies the methods of designing, organizing and evaluating the implementation of the educational and scientific process;

LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;

LOP 7 - Conducts scientific work using research and digital skills.

Learning Outcomes in Course (LOC):

LOC 1 –give undergraduates information about the main directions of the course

LOC 2 – designing a training course, using critical technologies in the study of this course
LOC 3 – create sorting and use the most effective training method.
Post requisites: not

Optional component 7

Course: ***Special chapters of electromagnetism and optics***
Intensity of the Course: 6 academic credits
Module Code: FMPhN-4
Module Name: Fundamentals of modern physics and Nanophysics
Prerequisites: PS 4308 Physics of solids, CP 4308 Crystal physics
Aim of the course: is the formation of students' skills and abilities to use the fundamental laws, theories of classical and modern physics, as well as methods of physical research to solve theoretical and experimental-practical learning problems from various fields of physics;
Short Description: In the course of studying the discipline, an introduction to the theory of the solid state is considered: the Drude theory, energy zones, the Fermi-Dirac distribution. Model of free electrons. Models of Debye and Einstein. Quantization of collective excitations in a solid, the concept of quasiparticles. Phonons in covalent, molecular and ionic crystals. Plasma waves in solids. Plasmon Screening Spin waves. Magnons. Quantum size effects. Adrerson, Mott and Lifshitz models for amorphous condensed state. Modern applications of the quantum theory of the solid state in quantum electronics, photonics and spintronics. Quantumpits, wiresandpoints
Learning Outcomes in EP (LOP):
LOP 6 - Uses modern problems of education and science, theoretical and practical knowledge of classical and modern physics in solving specific educational and scientific problems;
LOP 7 - Conducts scientific work using research and digital skills.
Learning Outcomes in Course (LOC):
LOC 1 – independent search, analysis and selection of information, training in its use in practice, providing scientific, theoretical, methodological and practical application in teaching the discipline;
LOC 2 – problems of development of knowledge and creative abilities of students, formation of knowledge and skills of the future specialist of physics; knowledge of basic concepts of laws of basic laws of physics;
LOC 3 – generalization of formulas and their use in everyday practice; mastering innovative pedagogical technologies; preparation for innovative, search, cultural, educational, skills.
Post requisites: not