# 6B01505- PHYSICS-COMPUTER SCIENCE

# 1. OPTIONAL COMPONENTS OF THE CYCLE OF CORE COURSES

**Optional component 1** 

Course: Mechanics Intensity of the Course: 6 academic credits Module Code: GPh-6 Module Name: General Physics Prerequisites: Physics (school course)

*Purpose:* formation of knowledge and concepts about the basic laws and postulates of mechanics, basic mechanical phenomena, physical models and hypotheses, and the limits of application of theories.

*Short Description:* The purpose of the discipline is to consider physical processes and phenomena related to the mutual movement of bodies in time in space. The content of the discipline includes kinematics, dynamics, statics and mechanics of liquids and gases. Students will learn how to describe movements and establish laws of motion that allow them to determine the position of the body at any moment, to determine the laws of interaction of bodies

Learning Outcomes in EP (LOP):

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

*LOP* 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy. *Learning Outcomes in Course (LOC):* 

LOC1 -is Able to classify differential equations and apply the necessary rod 1-mastering physical properties, phenomena and quantities that can be measured and expressed in numbers;

LOC 2-the ability to set up a simple mechanical experiment, perform calculations to measure certain physical quantities;

LOC 3-use of innovative technologies, understanding the meaning of certain mechanical phenomena encountered in practice.

LOC 4-the desire to improve their teaching skills, increase their knowledge, the ability to show their hard work and desire

LOC 5-application of new technologies in the pedagogical process; work with types of ICT information;

LOC 6-independent search, analysis and selection of information.

Post requisites: Molecular physics and thermodynamics.

**Optional component 1** 

Course: School physics

Intensity of the Course: 6 academic credits

Module Code: GPh-6

Module Name: General Physics

Prerequisites: Physics (school course)

*Purpose:* formation of students' knowledge about the content and organization of the educational process in general physics at school; preparation of future teachers for teaching physics in general education institutions.

*Short Description:* The purpose of the discipline is to consider the goals and content of physical education at school in the sections of general physics, methods, means and organizational forms of education. Students form knowledge about the content and organization of the educational process in general physics at school, prepare for teaching physics in general education institutions.

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy.

Learning Outcomes in Course (LOC):

LOC 1-main stages and regularities of the historical development of physics as a whole and its individual sections;

LOC 2-formulations of basic physical laws in the historical aspect and their changes over time;

LOC 3 – key experiments that led to a change in perceptions of the world around US;

LOC 4-main directions of development of modern physics and their assessment by the scientific community;

LOC 5-to make connections between physics and related Sciences: mathematics, computer science, engineering, chemistry, biology, as well as connections with philosophy and other Humanities;

LOC 6-use the historical and physical approach in the study of individual topics of the school physics course;

LOC 7-use knowledge about the main directions of development of modern physics to increase the attractiveness of students to the subjects of the natural science cycle.

Post requisites: Molecular physics and thermodynamics.

**Optional component 2** 

Course: Molecular Physics and Thermodynamics Intensity of the Course: 6 academic credits Module Code: GPh-6 Module Name: General Physics Prerequisites: Mechanics

*Purpose:* to study the course, it is necessary to study the state of systems in which processes are determined by molecular motion and intermolecular interactions, as well as to teach the student the ability to independently set and solve physical problems and problems.

*Short description*: Introduction to molecular (thermal) physics. Methods for describing the physical properties of substances. Molecular kinetic theory of gases. Temperature. Gas laws. Maxwell and Boltzmann distribution. Transfer phenomena. The first law of thermodynamics. The second law of thermodynamics. Work cycle. Efficiency. Real gases. Fluids. Solid bodies Phase transitions.

*Learning Outcomes in EP (LOP):* 

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy.

Learning Outcomes in Course (LOC):

LOC 1 Basic concepts and fundamental laws of molecular physics and thermodynamics; - molecular physics and phenomena in thermodynamics and features of their motion;

LOC 2 Basic concepts, quantities and their mathematical expressions and units of measurement in molecular physics; - a wide range of experiments and processing of measurement results; common methods;

LOC 3 main stages of molecular physics and thermodynamics; - apply the acquired knowledge in the course of laboratory work and expert activities;

LOC 4-apply the acquired knowledge in the field of molecular physics and thermodynamics in the study of professional physical disciplines, depending on the direction of training;

LOC 5 - work with scientific, educational and reference literature; analysis of the results of theoretical works and experiments in the field of molecular physics and thermodynamics.

Post requisites: Statistical physics and thermodynamics.

Optional component 3

Discipline: Probability theory in physics

Intensity of the Course: 6 academic credits

Module Code: GPh-6

Module Name: General Physics

Prerequisites: Mechanics

Purpose: subject is to develop skills in working with random variables and processes in physics.

*Short Description:* The purpose of the discipline is to study reversible and irreversible processes in thermodynamic systems using kinetic theory and explain them with a cluster model of various gas mixtures. Students learn to establish patterns of change of random variables in various typical situations, to determine patterns, probability distribution functions of a random variable and probability density.

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy. *Learning Outcomes in Course (LOC):* 

LOC 1 – familiarity with the subject of probability theory and basic concepts;

LOC 2 – Explanations of statistical physics underlying probability theory and mathematical statistics;

LOC 3 is a probability theory that describes the numerical values of the regularities of random events occurring in physical phenomena and discusses the methods of its practical application;

LOC 4 – as a mathematical science that studies the laws of random phenomena, it understands that it does not consider phenomena, but its mathematical models, understands the basic concepts in probability theory – events;

LOC 5 – generalize, discuss and generalize physical knowledge.

Post-requirements: Static physics and thermodynamics.

# **Optional component 4**

Course: Computer Architecture and Operating Systems

Intensity of the Course: 6 academic credits

Module Code: FT-5

# Module Name Fundamental training

Module name: Methodology of teaching programming languages

*Prerequisites:* Informatics (school course)

*Purpose:* studying of the basic concepts of the architecture of a personal computer, the device and the principle of operation of the most important components of the hardware and software of a personal computer, mechanisms for transferring and managing information. And also to give a systematic idea of the principles of construction and operation of operating systems.

*Short description:* The purpose of the discipline is to consider the types of computer architecture, I/O devices, processor, addressing methods, operating systems, processes and threads, as well as the capabilities of BIOS functions. Students will master the skills of assembling a computer from individual devices, assembling the motherboard, connecting cables, installing the operating system, allocating memory, disabling the OS.

Learning Outcomes in EP (LOP):

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

*LOP* 6 - rates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis.

Learning Outcomes in Course (LOC):

LOC 1 - uses interdisciplinary knowledge to solve applied problems;

LOC 2 - classifies computers according to various characteristics, characteristics and characteristics of different classes of computer;

LOC 3 - knows the main architectures used in building a computer, hardware and system configuration of the computer;

LOC 4 - has knowledge of the basic concepts, functions, compositions and principles of operation of operating systems; architecture of modern operating systems.

Post requisites: no.

**Optional component 5** 

#### Discipline: Computer systems

Intensity of the Course: 5 academic credits

Module Code: FT-5

Module Name: Fundamental training

*Purpose:* acquaintance of students with the basic concepts of system software and the possibilities of their use for the development of individual system components.

*Short description:* The purpose of the discipline is to master the theoretical and practical foundations of the construction and functioning of computer systems, as well as programming. Students know computer systems and complexes, apply applied software packages in the field of professional activity, designs, installs and uses computer networks, implements information protection measures in computer systems, owns the technical support of computer systems and complexes during their operation.

Learning Outcomes in EP (LOP):

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

LOP 6 - reates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis.

Learning Outcomes in Course (LOC):

LOC 1 - knows the composition, organization and principles of operation of the main components of open source software;

LOC 2 - possesses the knowledge and representation of the varieties of the physical and software system of data input – output;

LOC 3 - evaluates and uses the capabilities of operating systems, file systems, system programming systems. *Post requisites*: no.

### **Optional component 6**

Discipline: Electricity and magnetism

*Intensity of the Course*: 5 academic credits *Module code:* **GPh-6** 

Module name: General Physics

Prerequisites: Mechanics

*Purpose:* the purpose of studying the discipline is to present electromagnetism as a theory that arose as a result of generalization of observations, practical experience and experiment in the framework of lectures, practical and laboratory classes.

*Short description:* The purpose of the discipline is to form students' clear ideas about fundamental concepts and basic laws in the field of electrodynamics, the development of practical skills related to the application of the theoretical knowledge obtained for the study of the properties of electrical systems and phenomena, the formation of the basis for the study of subsequent sections of general and theoretical physics. Students have theoretical knowledge of electrostatics, direct and alternating electric current, magnetic field, electric vibrations and waves, improve their knowledge in practical and laboratory classes by solving problems and conducting laboratory work.

*Learning Outcomes in EP (LOP):* 

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy.

Learning Outcomes in Course (LOC):

LOC 1-physical meaning of electric and magnetic phenomena, methods of practical application of electric and magnetic phenomena, electrical and electronic processes in electrical circuits, their regularities;

LOC 2-building electrical circuits; knowledge of the design, operating principle, modes of devices and their characteristics, the use of electrical and electronic equipment in school.

LOC 3-restore order in electrical, radio engineering circuits and devices.

Post requisites: The beginnings of electrodynamics and STR.

**Optional component 7** 

Discipline: Electrodynamics and STR

Intensity of the Course: 5 academic credits

Module code: GPh-6

Module name: General Physics

Prerequisites: Mechanics

*Purpose:* Formation of modern physical and scientific outlook of students. Formation of students' knowledge and skills of applying fundamental laws, classical and modern theories of physics, as well as skills of conducting physical research as the basis of future professional activity.

*Short description:* The purpose of the discipline is to study the basic concepts of relativistic physics through electrodynamics and special relativity, a component of theoretical physics. Provides students with the opportunity to learn the basics of relativistic mechanics and electrodynamics, to deeply explore the relationship between classical and relativistic concepts and to use the relativistic concept to explain electrodynamics.

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy Learning Outcomes in Course (LOC)

LOC 1-to reveal the essence of the basic concepts, laws, theories of classical and modern physics in their internal connection and integrity.

LOC 2-the physical content and meaning of the main provisions, laws, laws and studied sections of SRT and electrodynamics;

LOC 3-statistical methods of processing experimental data obtained in an experiment using a computer under conditions of large computations;

LOC 4 anyktau definition of the goal, problem solving, formation of a hypothesis about possible ways to solve the problem, selection of the procedure for collecting and processing the necessary data, collection, processing and analysis of the results;

LOC 5-conducting qualitative and quantitative research on the profile of the specialty with the help of modern physical scientific equipment;

LOC 6-correct interpretation of the information received to make optimal decisions taking into account specific situations;

LOC 7-correlate the solution of problems arising in practice with the physical nature of the phenomena under consideration and find the correct physical interpretation.

Post-requirements: no

# **Optional component 8**

Course: Optics

Intensity of the Course: 5 academic credits Module Code: GPh-6 Module Name: General Physics

Prerequisites: Mechanics

*Purpose:* the main task of the discipline is to create a fundamental knowledge base, on the basis of which in the future it is possible to develop a more in-depth and detailed study of all sections of physics to teach students to quantitatively solve specific problems within the framework of accepted approximations. Identify ways to use optical phenomena in technical devices.

*Short Description:* The purpose of studying the discipline is the formation of theoretical knowledge and practical skills in the application of optical laws to solve a wide range of problems in various fields of science and technology, as well as the presentation of the physics of optical phenomena as a generalization of observations, practical experiments and experiments.

*Learning Outcomes in EP (LOP):* 

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy Learning Outcomes in Course (LOC):

LOC 1 - on the relationships in optics and the relationship of optics with mathematics, chemistry, engineering, and other branches of physics;

LOC 2-basic concepts and laws of optics, basic methods for determining parameters during laboratory work.

LOC 3-correctly apply the laws of physics to analyze and solve specific physical problems.

LOC 4-conduct optical research methods; independently conduct experimental research and processing of results, work with measuring equipment.

Post requisites: no

Optional component 9

*Course:* Theory of oscillations and waves *Intensity of the Course:* 5 academic credits *Module Code:* **GPh – 6** 

### Module Name: General physics

Prerequisites: Mechanics

Purpose: to form students ' modern understanding of the main methods of the theory of electromagnetic waves.

*Short Description:* The purpose of the discipline is to study physical phenomena characterized by cyclic changes in physical quantities in time and space. Students can consider mechanical and electromagnetic processes and understand the theory of vibrations and waves based on kinematics and dynamics *Learning Outcomes in EP (LOP):* 

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy Learning Outcomes in Course (LOC):

LOC 1-General provisions of the theory of electromagnetic waves;

LOC 2-practical application of theoretical knowledge, methods of theoretical and experimental research in solving physical problems;

LOC 3- ability to use basic knowledge and information management skills to solve physical problems. *Post requisites:* Atomic and nuclear physics

**Optional component 10** 

#### Discipline: Atomic and nuclear physics

Intensity of the Course: 5 academic credits

Module code: GPh-6

Module name: General Physics

Prerequisites: Molecular Physics and Thermodynamics

*Purpose*: formation of the student's complete system of knowledge on the basics of modern physics of atoms and atomic phenomena, basic quantum concepts, development of skills for building quantum mechanical models and solving physical problems.

*Short description:* The purpose of the discipline is to study the structure of the atom and the atomic nucleus and related processes. Students through the discipline describe the phenomena occurring at the level of the microcosm: molecule, atom, particle nuclei, study the structure of atoms, radiation, interaction of atoms and molecules, various processes of decay and synthesis, experimental methods for obtaining and detecting particles

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy

Learning Outcomes in Course (LOC):

LOC 1-physical models that reflect the properties of the microcosm;

LOC 2-basic quantum mechanical laws, their mathematical expression and limits of applicability;

LOC 3-concepts and basic laws of natural science, in particular, atomic physics and the use of the acquired knowledge in practice;

LOC 4-practical application of theoretical knowledge, methods of theoretical and experimental research in solving physical problems;

LOC 5-use the basic laws of natural science disciplines in professional activities, apply methods of mathematical analysis and modeling, theoretical and experimental research;

LOC 6-applications of mathematical apparatus for solving physical problems. Acquisition of the necessary skills for practical use of theoretical knowledge.

Post requisites: Fundamentals of quantum mechanics.

**Optional component 11** 

*Course:* **The beginnings of modern physics** *Intensity of the Course:* 5 academic credits

### Module Code: **GPh – 6**

# Module Name: General physics

Prerequisites: Molecular Physics and Thermodynamics

*Purpose:* Improvement of knowledge through revealing the importance of cognitive practice, structural description of matter and its unity, versatility of fundamental conservation laws, dialectical characterization of physical phenomena, logic of physical theory, problems of correlation between theory and practice for the development of physics.

*Short Description:* The purpose of the discipline is to study the concepts of modern physics, laws, theories, methods and means as the main components of scientific and technological progress. Modern physics studies achievements in economics and problems related to the world (global environmental and energy).

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy *Learning Outcomes in Course (LOC)*:

*LOC* 1 - formation of knowledge, creative, cognitive ability; Formation of professional competence by analyzing the results of theoretical work and experiments conducted in the course of the development of physical science;

LOC 2-Structure and content of the University's physics course. Students study the psychological, scientific and pedagogical foundations of the structure and content of the University physics course, form the basis of knowledge of their relationship;

LOC 3-Teach how to apply the laws and laws of physics in practice, learn how to use various physical devices, equipment and experimental installations;

LOC 4-to make conditions for the development of students ' research skills within the framework of the scientific foundations of school physics, to develop competencies for working with scientific, educational, and reference literature.

Post requisites: Fundamentals of quantum mechanics

**Optional component 12** 

Course: Static physics and thermodynamics

Intensity of the Course: 5 academic credits

Module Code: SChPh-9

Module Name: Selected chapters of physics

Prerequisites: Molecular Physics and Thermodynamics

*Purpose:* formation of students ' modern ideas about the main methods of statistical and thermodynamic description of the properties of equilibrium and non-equilibrium macroscopic systems consisting of a large number of particles.

*Short Description:* The purpose of the discipline is to teach basic thermodynamic and statistical knowledge of macroscopic systems, the application of knowledge to solving applied problems. To teach to pay special attention to various methods characteristic of thermodynamic and statistical theories in solving tasks. Students should know the basic concepts and fundamentals of thermodynamics and statistical physics, be able to set problems solved in thermodynamics and statistical physics, study solution methods, find numerical values of parameters of each individual physical system obtained by the Gaussian system and international units.

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy

Learning Outcomes in Course (LOC):

LOC 1-to Know the fundamental principles (principles) and methods of thermodynamics for studying the properties of macrosystems in a state of thermodynamic equilibrium;

LOC 2-to know the basic concepts and provisions of statistical physics; to know the basic distributions of SP. f.;

LOC 3-to know the modern aspects of the application of statistical physics as a method for studying the structure of matter.

LOC 4 - be able to apply the basic laws of thermodynamics to determine the thermal properties of macrosystems;

LOC 5 – be able to apply the basic concepts of statistical physics to calculate the thermodynamic characteristics of simple macrosystems.

LOC 6-Have the skills to calculate macro parameters of the system using the method of cycles and the method of characteristic functions;

LOC 7-have the skills to calculate the macroparameters of the system using the Gibbs statistical ensemble and the phase cell method.

Post requisites: no.

**Optional component 13** 

Course: Field theory Intensity of the Course: 5 academic credits Module Code: SCPh – 8 Module Name: Selected Chapters of Physics Prerequisites: Electricity and magnetism

*Purpose:* Research of electromagnetic and gravitational fields, their main features, equations of electromagnetic fields and their physical characteristics, features of gravitational fields and adaptation for application by students of the laws of interactions of electromagnetic fields, the causes of occurrence of gravitational weak and strong fields.

*Short Description:* The purpose of the discipline is to study the interaction of the field and matter as a modern introduction to the fundamental physics of interaction. Students study in depth the concepts of field, matter, and the main problems of field theory. examines the basic details of field theory and the simplest models of elementary particle physics. *Learning Outcomes in EP (LOP):* 

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy Learning Outcomes in Course (LOC):

LOC 1 - can derive basic equations describing the field features, can apply basic methods for solving problems;

LOC 2 - can anticipate problems of non-fulfillment of the Einstein equation and the superposition principle, and can apply various methodological skills in the course of mastering the course material;

*LOC* 3 – the Physical meaning of the field, its main features, equations of gravitational fields, their physical characteristics, properties of the gravitational field and the main equations describing the field;

LOC 4-Proof of the theorems considered in the course program and the conclusion of formulas, the ability to apply the proposed literature, the development of a conditional language intended for the presentation of physical concepts;

LOC 5 – be able to apply their knowledge in other areas of physics, theoretical computer science, the basics of artificial intelligence, logic programming, etc.

LOC 6-Failure of the superposition principle for electric fields, recording of physical formulas.

*Post requisites:* Physical crystallography and fundamentals of nanotechnology.

**Optional component 14** 

Course: Bases of quantum mechanics

Intensity of the Course: 5 academic credits

Module Code: SChPh-9

Module Name: Selected chapters of physics

Prerequisites: Atomic and nuclear physics

*Purpose:* quantum field theory describing the laws of motion and interaction of microparticles taking into account fields, gravitational, electromagnetic.

*Short Description:* The purpose of the discipline is to form a quantum-mechanical understanding of micro-objects. In the course, which is one of the main directions of physics development, students study the processes of the microcosm on a microscopic scale and the properties of microparticles, the laws of their motion and interaction, based on their understanding of the discreteness of quantum quantities, the wave nature and the probabilistic (statistical) method of describing objects.

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy *Learning Outcomes in Course (LOC):* 

LOC 1 – be able to describe the basic properties of quantum, gravitational, and electromagnetic fields using operators. LOC 2-select and use the best research methods.

LOC 3-technology for describing quantum phenomena and methods for applying them in practice.

Post requisites: Physical crystallography and fundamentals of nanotechnology.

# **Optional component 15**

Course: Solid state physics

Intensity of the Course: 5 academic credits

Module Code: SChPh-9

Module Name: Selected chapters of physics

Prerequisites: Atomic and nuclear physics

*Purpose:* Subject "physics of solids" to show the features of crystal structures by studying their properties and the physical laws of the crystal lattice; to master the basic physical concepts, quantities and their mathematical expressions and units of measurement. The theory of crystal physics as a result of the achievements of science at the present stage, the results of various observations and experiments and experiments performed.

*Short Description:* The discipline defines the properties of solids using the laws of particles and symmetry. The discipline studies the structure of bodies, the study of the atomic-electronic structure of crystalline materials, the relationship between their composition, structure and various physical properties

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy Learning Outcomes in Course (LOC):

LOC 1-The basis of solid state physics and the theory of the crystal lattice and gives its main sections, the history of its development and data related to the theory of modeling.;

LOC 2-understands the composition and structure of modern technology, knowing the model structure of solids;

LOC 3-gets the opportunity to quickly master modern technologies, forms skills to work with them;

LOC 4-conditional writing of mathematical expressions of physics phenomena, understanding the physics of phenomena in it, mastering the principles of work.

Post-requirements: Physical crystallography and the basics of nanotechnology

# 2. OPTIONAL COMPONENTS OF THE CYCLE OF MAJOR DISCIPLINES

# **Optional component 1**

Discipline: Physical practicum

Intensity of the Course: 6 academic credits

Module Code: POTM-8

Module Name: Profession-oriented training module

Prerequisites: Methodology of teaching physics

*Purpose:* practical reproduction and study of physical phenomena and processes and various physical laws based on theoretical knowledge and practical obtaining of quantitative relations between physical quantities.

*Short description:* The purpose of the subject is the formation of experimental ideas and independent conduct of experiments, the ability to work with instruments, the expansion and generalization of the acquired knowledge in physics. Students can use their knowledge to work with physical installations and conduct experiments, independently solve experimental problems.

*Learning Outcomes in EP (LOP):* 

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy. *Learning Outcomes in Course (LOC):* 

LOC 1-possesses a system of knowledge about fundamental physical laws and theories, the physical essence of phenomena and processes in nature and technology;

LOC 2-physical concept, classification of tasks and the possibility of their application in the educational process;

LOC 3-application of various problem solving technologies, including mathematical methods and methods;

LOC 4-Devices used in a school physics experiment;

LOC 5-forms of organization of students' academic work in solving problems in physics;

LOC 6 - the ability to identify and calculate experimental and computational errors;

LOC 7-competent use of physical and mathematical scientific languages.

Post-prerequisites: methods of teaching physics in Higher education.

# **Optional component 1**

### Course: Methodology of Solving Complex and Structured Problems in Physics

Intensity of the Course: 6 academic credits

Module Code: POTM-8

Module Name: Profession-oriented training module

Prerequisites: Methodology of teaching physics

*Purpose:* Introduction to the method of solving complex problems in physics. Algorithmic and heuristic solution methods.

*Short Description:* The purpose of the discipline is to consider the methodology of solving physically complex and structural problems, their analysis, the choice of optimal methods and methods of solution. Students can classify tasks and adjust the ways and methods of solving them. Can carry out a detailed analysis of solutions to a number of complex and structural problems in sections of physics

*Learning Outcomes in EP (LOP):* 

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy

*Learning Outcomes in Course (LOC):* 

LOC 1-the ability to self-organization and self-education;

LOC 2-has a system of knowledge about fundamental physical laws and theories, the physical nature of phenomena and processes in nature and technology;

LOC 3-the concept of "physical task", classification of tasks and their possible use in the educational process;

LOC 4-devices used in a school physics experiment;

LOC 5 – confidence level of the number;

LOC 6-various technologies for solving problems, including the use of mathematical techniques and methods;

LOC 7-forms of organization of students ' academic work in solving problems in physics;

LOC 8-detect and calculate experimental and computational errors;

LOC 9-competent use of physical and mathematical scientific languages;

Post requisites: methods of teaching physics in higher education.

**Optional component 2** 

Course: Technology of school physical experiment

Intensity of the Course: 6 academic credits

Module Code: POTM-8

Module Name: Profession-oriented training module

Prerequisites: Methodology of teaching physics

*Purpose:* use modern information technologies for conducting, analyzing and processing the results of a physical experiment.

*Short Description:* The purpose of the discipline is to form the skills to methodically organize school physical experiments, measure physical quantities, process the results obtained and analyze them correctly, as well as the ability to design school physical devices and equipment. Students develop competencies in the practical application of theoretical knowledge, organization and conduct of experiments in the framework of a school physics course

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy. Learning Outcomes in Course (LOC):

LOC 1-Systematization of knowledge about the types of experiment, the essence of the technique and methodology of the experiment (their difference and relationship).

LOC 2-Disclosure of the possibilities of a physical experiment for the development of cognitive activity of students.

LOC 3-Formation of students ' skills to create and master the methods and techniques of the experiment.

LOC 4-Introduction to the prospects for the development of technology and methods of school physical experiment, with the use of new technologies in the educational experiment.

Post requisites: methods of teaching physics in higher education.

**Optional component 2** 

# Course: Modeling physics processes

Intensity of the Course: 6 academic credits

Module Code: POTM-8

Module Name: Profession-oriented training module

Prerequisites: Fundamentals of Scientific Research (in Computer Science).

*Purpose:* to acquaint future teachers with generalizing methods of using computer and information technologies in teaching physics, to help future teachers in conducting physical practice classes using computer technology.

*Short Description:* The purpose of the discipline is to explain physical phenomena by creating models using modern computational methods. Teaches students such principles as science, visibility, consistency, activity of learning through computer modeling of physical objects and phenomena in the educational process.

Learning Outcomes in EP (LOP):

LOP 7 - Visualizes modern scientific vision, fundamental laws and principles of physics with the help of digital resources and forms a scientific approach;

LOP 8- Solves complex, experimental, research, Olympiad problems in general and theoretical physics with the help of mathematical apparatus;

LOP 10 - Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics.

LOP 11- To explain physical phenomena based on fundamental theories and laws of physics and astronomy

Learning Outcomes in Course (LOC):

LOC 1-A student learns to organize the educational process and lessons of a physical workshop using computer technology.

LOC 2-owns scientific and methodological expertise of software products and virtual sketches of physical processes.

LOC 3-knows the methods of applying theoretical knowledge in practice.

LOC 4-owns methods of mathematical modeling of the basic phenomena of physics.

Post-prerequisites: methods of teaching physics in Higher education.

**Optional component 3** 

Course: Computer Graphics

Intensity of the Course: 6 academic credits

*Module code: SE* – 8

Module name: STEM education

Prerequisites: Information and Communication Technologies (in English).

*Purpose:* familiarization of students with the basics of computer graphics and digital design, the formation of practical skills of computer editing, editing and converting vector and digital images in graphic stacks, consideration of the methodology of teaching computer graphics in high school.

*Short Description:* The purpose of the discipline is to study modern methods of creating computer graphics and the formation of skills for their application in professional activities. In the course of studying the course, students form knowledge about the features of storing graphic information, study the features of modern software used in creating computer graphics, develop skills in working with graphic libraries in modern graphics packages and systems.

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

LOP 6 - reates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis;

Learning Outcomes in Course (LOC):

LOC 1 – creates any bitmap and vector images on the computer;

LOC 2 – independently edits any scanned images using graphic editors;

LOC 3 – knows the methodology of teaching computer graphics in high school.

Post requisites: no.

#### **Optional component 4**

Course: Methodology of Development Interactive Interface

Intensity of the Course: 6 academic credits

Module code: FPHM-7

Module name: Fundamentals of Programming and Higher Mathematics

Prerequisites: Information and Communication Technologies (in English).

*Purpose:* Formation of an idea about the technical and software tools for implementing competencies in the field of creating an interactive interface using modern software, as well as the skills of developing a user interface. Master the methodology for creating an interactive interface.

*Short Description:* The purpose of the course is to familiarize user interface development with the use of modern software, as well as user interface development skills. Students have the skills of using electronic educational resources on interactive interface design, developing interface design, compiling a description of the interactive interface development process, creating visual components of the user interface, justifying the interface design solution based on the principles of ergonomics and design trends

*Learning Outcomes in EP (LOP):* 

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

LOP 6 - reates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis.

Learning Outcomes in Course (LOC):

LOC 1 – able to analyze the professional experience of developing interactive interfaces using information and communication technologies;

LOC 2 – can test using an interactive interface;

LOC 3 – compiles technical documentation and develops a design solution for the interface;

LOC 3 – develops design projects for an interactive interface.

Post requisites: no.

**Optional component 5** 

Course: Cybersecurity

Intensity of the Course: 5 academic credits

Module Code: NTDP-7

Module Name: Network technologies and data processing

Prerequisites: no

*Purpose:* lay down a methodology for ensuring the cybersecurity of information systems and information resources used in professional activities. Students learn the structure of an information security system, basic standards for information security management, and the study of theoretical, methodological and practical problems in the field of cybersecurity.

*Short Description:* The purpose of the discipline is to lay down a methodology for ensuring cybersecurity of information systems and information resources used in professional activities. Students study the structure of the information security system, the basic standards for information security management, the study of theoretical, methodological and practical problems in the field of cybersecurity.

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

LOP 6 - reates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis.

Learning Outcomes in Course (LOC):

LOC 1 – Develop secure server-side client web and mobile applications;

LOC 2- Monitoring, analysis and comparison of the effectiveness of software and hardware for information security in operating systems and networks.

LOC 3 - Carrying out the correct operation of system administration and software and hardware protection tools. *Post requisites:* no

**Optional component 6** 

## Discipline: Software and Data Security

Intensity of the Course: 5 academic credits

Module code: FPHM-7

Module name: Fundamentals of Programming and Higher Mathematics

Prerequisites: Information and Communication Technologies (in English).

*Purpose:* development of projects of systems and subsystems for protection of programs and data in accordance with the terms of reference.

*Short description:* The purpose of the discipline is to consider the basic encryption methods, basic algorithms used in cryptosystems, as well as measures taken to improve the security of programs and data. Students will learn how to use cryptographic protocols in solving practical problems, detect, fix and prevent vulnerabilities in computer networks, identify vulnerabilities at different stages of the software lifecycle.

Learning Outcomes in EP (LOP):

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

LOP 6 - reates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis;

Learning Outcomes in Course (LOC):

LOC 1 - knows the requirements for the audit subsystem and audit policy; protective mechanisms and means of ensuring the security of programs and data;

LOC 2 - implements security breach countermeasures using a variety of software and hardware protections;

LOC 3 - possesses the skills of developing software modules that implement tasks related to ensuring the security of programs and data; skills in assessing the level of protection of programs and data.

Post requisites: no.

**Optional component 7** 

# Discipline: Programming Olympiad tasks

Intensity of the Course: 4 academic credits

Module code: NTDP-7

Module name: Network technologies and data processing

Prerequisites: Methods and technology of teaching programming.

*Purpose:* to introduce students to the basic and common algorithms used in Olympic programming. As part of the course, students will learn various algorithms, line scanning method, dynamic programming, various algorithms on graphs, tree segments, etc. counts.

*Short Description:* The purpose of the subject is to study the methods of Olympiad programming for mastering knowledge in the field of programming technology. Students will be able to study the use of basic algorithmic constructions for solving Olympiad problems, master the basics of structural programming; be able to develop an algorithm based on structural programming; consolidate algorithmizing and programming skills based on learning a programming language; be able to use data structures and methods of their processing to solve typical Olympiad programming problems.

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

LOP 6 - reates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis.

and algorithm analysis;

Learning Outcomes in Course (LOC):

LOC 1 – ability to solve standard problems of professional activity based on information and bibliographic culture using information and communication technologies and taking into account the basic requirements of information security

LOC 2 – ability to develop and apply algorithmic and software solutions in the field of system and application software in the field of Olympiad problems in modern computer science.

Post requisites: no.

## **Optional component 8**

Discipline: Scientific Bases of a School Course of Informatics

Intensity of the Course: 4 academic credits

Module Code: POTM-8

Module Name: Profession-oriented training module.

Prerequisites: Fundamentals of Scientific Research (in Informatics).

*Purpose:* to ensure a solid and conscious mastery by students of the basics of knowledge about the processes of obtaining, transforming, storing, transferring and using information and, on this basis, to reveal the role of informatics in the formation of a modern scientific picture of the world, the value of information technologies.

*Short description:* The purpose of the discipline is to review scientific papers in the field of information technology focused on school informatics. Students master the techniques of organizing scientific work at school, methods of designing research works, the use of basic and auxiliary tools for the development of design works

Learning Outcomes in EP (LOP):

LOP 4 - Demonstrates knowledge and understanding of computer hardware and system software, computer architecture.

LOP 6 - reates algorithms and develops computer programs, interface design and mobile applications for solving applied problems, including those related to robotics programming in the field of education;

LOP 10- Owns the methodology of organizing and conducting physical experiments in compliance with the rules of operation and safety of laboratory devices in physics;

LOP 12 - Demonstrates knowledge on storage, search, processing of graphic information, develops methods of database design and algorithm analysis;

Learning Outcomes in Course (LOC):

LOC 1 - uses natural science and mathematical knowledge to navigate in the modern information space;

LOC 2 - knows the current state of the level and directions of development of information technology and software;

LOC 3 - analyzes the current state of the scientific foundations of school computer science;

LOC 4 - predicts the prospects for improving the scientific foundations of school computer science;

Post requisites: no.