NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

PHYSICS DEPARTMENT

"CONFIRMED"
Dean of the Faculty of Plant Protection,
Biotechnology and Ecology
_____ Yulia KOLOMIETS
"23" 05 2024 year.

"APPROVED"
at the meeting of the department Physics
Protocol № 5 dated "07" of May 2024 year.
Head of Department
_____ Volodymyr BOYKO

"REVIEWED"
Program Coordinator _____

_____
Program Coordinator
_____ Volodymyr BOGOLYUBOV

PROGRAM OF THE COURSE

Mathematics and physics (physics)

Specialization 101 « Ecology»
Educational program Natural sciences

Faculty (Institute) Plant Protection, Biotechnology and Ecology
Developers: candidate of physical and mathematical sciences, associate professor Oksana Godlevska

Kyiv – 2024

1.Description of the course “Mathematics and physics (physics)”

Field of knowledge, specialization, educational program, educational degree		
Educational degree	*Bachelor's*	
Specialization	101 « Ecology»	
Educational program	Natural sciences	
Characteristics of the course		
Type	Compulsory	
Total number of hours	60	
Number of ECTS credits	2	
Number of content modules	2	
Course project (work) (if applicable)	-	
Form of assessment	*Exam*	
Indicators of the course for full-time and part-time forms of study		
	Full-time form of study	Part-time form of study
Course (year of study)	1	
Semester	1	
Lecture classes	15 hr.	
Practical, seminar classes	15 hr.	
Laboratory classes	-	
Self-study	30 hr.	
Individual assignments	-	

2.**Purpose, objectives, and competencies of the course**

The discipline "Mathematics and Physics" is one of the main parts of the theoretical training of bachelors in the specialty 101 "Ecology, Environmental Protection and Balanced Nature Management", that is, the basis without which a full study of the disciplines of the cycle of professional and practical training of such specialists is impossible.

The Purpose of studying the discipline "Physics" is the consistent study by students of the basic laws and provisions of physics in order to understand the general regularities of natural phenomena; the use of these laws in the prompt resolution of problems; illumination of possible applications of physical methods and devices in practical activities.

The tasks of the academic discipline "Physics" are as follows:

Providing students with sufficiently broad training in the field of physics, mastery of fundamental concepts and theories of classical and modern physics, which provides them with effective mastery of special subjects and the further possibility of using physical principles. This also includes teaching students methods and skills for solving specific problems and familiarizing them with measuring equipment.

Formation of students' scientific outlook and modern physical thinking. This task should also be considered as an essential part of the humanitarian training of the future specialist, since most issues of the history of science and philosophy can be demonstrated during the teaching of a physics course. As a result of studying the academic discipline "Mathematics and Physics", the student should

know:

basic physical quantities, units of their measurements, basics of error theory and rules for processing measurement results, modern means of measuring physical quantities

- fundamental concepts and theories of classical and modern physics in order to effectively master special educational disciplines and use knowledge of physical laws in future work;

- methods of solving practical physical problems and problems;

- principles of operation of devices;

be able to: - use measuring tools, perform mathematical and statistical processing of measurement results;

- using physical conditions, laws and theories, apply the acquired theoretical and practical knowledge after studying special disciplines in the future work in the specialty;

- explain physical processes and phenomena that occur in the natural environment, as well as during the operation of various types of equipment.

Acquisition of competencies

The study of the academic discipline "Mathematics and Physics" contributes to the fact that, according to this standard, the student is able to acquire:

general competencies:

GC8 Ability to conduct research at the appropriate level.

professional (special) competences:

SC2. Ability to critically understand basic theories, methods and principles of natural sciences

SC3. Understanding the main theoretical provisions, concepts and principles of mathematical and socio-economic sciences.

Program learning outcomes (PLO):

PLO3. Understand the main concepts, theoretical and practical problems in the field of natural sciences, which are necessary for analysis and decision-making in the field of ecology, environmental protection and balanced nature management

PLO19. To raise the professional level through continuing education and self-education.

PLO21. Be able to choose optimal methods and tools for research, data collection and processing.

3. Program and structure of the scientific discipline

Content module 1. Mechanics. Molecular physics and thermodynamics.

Lecture 1.

TOPIC 1.1. Mathematical data processing.

Mathematical apparatus as a means of research and discovery of physical phenomena. A mathematical concept from a school physics course, which is not enough to master this course. Elements of differential and integral calculus. Physical meaning of derivative and differential. The subject of physics. Matter and motion. Forms of movement of matter. Methods of physical research. The connection of physics with other sciences and technology, their mutual influence.

Lecture 2.

TOPIC 1.2. Kinematics of a material point.

Mechanical movement. Reference systems. Material point. Trajectory. Movement, path, speed. Acceleration, tangential and normal acceleration. The main characteristics of the movement of a material point in a circle: angular speed and acceleration, frequency and period of rotation. The relationship between linear and angular characteristics of movement. Units of the SI system (independent processing).

TOPIC 1.3. Dynamics of a material point.

The main task of dynamics. Newton's first, second and third laws. Inertial reference systems. Galileo's principle of relativity. Pulse. The law of conservation of momentum of the system of material points. Center of mass of a mechanical system. Types of forces in mechanics.

Lecture 3.

TOPIC 1.4. Work and energy.

Power work. Power. Conservative and non-conservative forces. Kinetic energy of a material point and its connection with work. Potential energy and its use for calculating work. The total mechanical energy of the system of bodies. The law of conservation of energy in mechanics. Elastic forces. Potential energy of an elastically deformed body. The law of universal gravitation. Potential energy in the gravitational field near the Earth's surface. The work of the force of friction.

TOPIC 1.5. Dynamics of rotary motion.

Rotational movement of the body. The moment of inertia of a material point and a body. Steiner's theorem. Kinetic energy of a body that rotates around a fixed axis. A moment of power. The law of dynamics of rotary motion. The moment of momentum of a material point and a body that rotates around a fixed axis. The law of conservation of momentum.

Lecture 4.

TOPIC 1.6. Fundamentals of molecular kinetic theory.

Molecular-kinetic and thermodynamic methods of studying macroscopic phenomena. Basic provisions of the molecular-kinetic theory. System status parameters. An ideal gas as a model of real gases. Isoprocesses. Ideal gas laws. Equation of state of an ideal gas. The basic equation of the molecular-kinetic theory of ideal gases. The number of degrees of freedom and the average kinetic energy of polyatomic gas molecules. Internal energy of an ideal gas. Distribution of gas molecules by velocities.
Real gas. Equation of state of a real gas.

Lecture 5.

TOPIC 1.7. Basics of hydrodynamics and aerodynamics

Movement of an ideal fluid. Flow continuity equation, Bernoulli's equation. Movement of a viscous liquid. Newton's equation for a viscous liquid. Stokes' law. Laminar and turbulent flows.

Surface tension. Capillary phenomena. Laplace's formula.

Atmospheric particles. Movement of atmospheric particles.

TOPIC 1.8. Basics of thermodynamics.

The work of a gas with a change in volume. Internal energy of a thermodynamic system. The first law of thermodynamics, its application to various isoprocesses in gases.

Gas operation in various isoprocesses. Adiabatic process. Poisson's equation. The direction of nature's processes. The second law of thermodynamics. Reversible and irreversible processes.

Carnot cycle. Cycle efficiency factor of the Carnot cycle.

Entropy and its physical meaning. The principle of entropy growth.

Content module 2. Electrostatics and direct electric current Magnetism. Oscillations and waves. Optics. Physics of the atom and atomic nucleus.

Lecture 6.

TOPIC 2.1. Electrostatics.

Basic properties of electric charges, elementary charge. Law of conservation of electric charge. Coulomb's law. Electrostatic field. Electric field strength. The field strength of a point charge, a charged plane. The principle of superposition of electric fields. Field lines of force.

Work of field forces when charges are moved. Potential. Point charge field potential. The relationship between field strength and potential. Equipotential surfaces.

Distribution of charges in a conductor. Electrical capacity of the conductor. Capacitors.

TOPIC 2.2. Direct current.

Electric current. Current strength and density. External forces. Electromotive force. Current source. Ohm's law for a section of a circle and for a complete circle. Kirchhoff's rules. Electrical resistance, electrical conductivity. Dependence of resistance on temperature.

Work and power of electric current. Joule-Lenz law

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Lecture 7.

TOPIC 2.3. Magnetic field. The phenomenon of electromagnetic induction.

Basic properties of the magnetic field. Magnetic induction vector, magnetic field lines of force. Magnetic field strength. Effect of a magnetic field on a current-carrying conductor. Ampere's law. Lorentz force. Movement of charged particles in a magnetic field. Biot-Savard-Laplace law.

The principle of superposition of magnetic fields. Magnetic field of rectilinear and ring currents, solenoid.

Magnetic flux. Operation when moving a circuit with a current in a magnetic field. The phenomenon of electromagnetic induction. Faraday's law of electromagnetic induction, Lenz's rule. The phenomenon of self-induction. Electromotive force self-induction. Electromagnetic field. Magnetic properties of matter. Earth's magnetic field.

TOPIC 2.4. Harmonic oscillations. Waves.

Oscillating processes. Equation of harmonic oscillations; amplitude, phase, period, frequency, cyclic frequency of harmonic oscillation. Differential equation of harmonic oscillations. Harmonic oscillations of a spring pendulum. Physical and mathematical pendulums. Dynamics of mechanical harmonic oscillations. Kinetic, potential and total energy of mechanical harmonic oscillations.

Longitudinal and transverse waves. Wave length and speed. Wave front and wave surface. Electromagnetic waves, their main properties (transverse, propagation speed, refractive index, intensity). The electromagnetic nature of light.

Lecture 8.

TOPIC 2.5. Geometric optics

Laws of reflection and refraction of light. Absolute and relative refractive indices. Full internal reflection. The principle of operation of the optical fiber.

TOPIC 2.6. Physics of the atom and atomic nucleus.

Rutherford's model of the atom. The composition of the nucleus, protons and neutrons. Isotopes.

The phenomenon of radioactivity. Composition of radioactive radiation. Basic properties of alpha and beta decays. Law of radioactive decay.

3. The structure of the scientific discipline

Names of content modules and topics	Number of hours											
	full-time form						Part-time form					
	total	including				self	total	including				self
		l	p	lab	ind			l	p	lab	ind	
1	2	3	4	5	6	7	8	9	10	11	12	13
Content module 1. Mechanics. Molecular physics and thermodynamics.												
Topic 1.1.Mathematical data processing	7	2	2			3						
Topic 1.2. Kinematics of a material point.	3	1				2						
Topic 1.3. Dynamics of a material point	5	1	2			2						
Topic 1.4. Work and energy.	3	1				2						
Topic 1.5. Dynamics of rotary motion.	5	1	2			2						
Topic 1.6. Molecular kinetic theory of ideal gases.	3	1				2						
Topic 1.7. Fundamentals of hydrodynamics and aerodynamics	5	1	2			2						
Topic 1.8. Basics of thermodynamics.	3	1				2						
Content module 2. Electrostatics and direct electric current Magnetism. Oscillations and waves. Optics. Physics of the atom and atomic nucleus.												
Topic 2.1. Electrostatics	5	1	2			2						
Topic 2.2. Direct current.	4	1	1			2						
Topic 2.3. Magnetic field. The phenomenon of electromagnetic induction.	5	1	2			2						
Topic 2.4. Harmonic	3	1				2						

oscillations. Waves.												
Topic 2.5. Geometric optics	5	1	2			2						
Topic 2.6. Physics of the atom and atomic nucleus.	4	1				3						
Total hours	**60**	**15**	**15**			**30**						

4.Seminar topics

№	Topic title	Number of hours
1	-	-

5.Laboratory class topics

№	Topic title	Number of hours
1	-	-

6.Practical class topics

№	Назва теми	Number of hours
1	Introduction to practical works. Determination of errors for direct measurements	2
2	Practical work 1 "Determining the acceleration of free fall using a mathematical pendulum"	2
3	Practical work 2 "Determining the moment of inertia by the method of torsional oscillations"	2
4	Practical work 3 "Determination of the coefficient of internal friction by the Stokes method."	2
5	Practical work 4 "Research of the electrostatic field".	2
6	Practical work 5 "Determining the horizontal component of the induction of the Earth's magnetic field."	2

7	Practical work 6 "Determining the refractive index using a microscope."	2
8	Final topic	1

7.Independent work topics

№	Topic title	Number of hours
1	Processing of lecture material	6,5
2	Preparation for laboratory classes	6,5
3	Preparation for control works (testing)	13
4	Independent work 1 - answers to three questions on the topics of Module 1	2
5	Independent work 2 - answers to three questions on the topics of Module 2	2

8.Teaching methods.

The following teaching methods are used when teaching the discipline:

1. Lecture.

2. Practical work - to use acquired knowledge to solve practical problems.

9. Forms of control

When teaching the discipline, the following forms of control are provided during the semester for full-time students: oral survey and express testing in laboratory classes, defense of reports on individual laboratory tasks, modular control works, exam at the end of the 1st semester.

10.Distribution of grades received by students.

Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 03.03.2021, protocol №7)

Student rating, points	National grade based on exam results	
	Exams	Credits
90-100	Excellent	Passed
74-89	Good	
60-73	Satisfactory	
0-59	Unsatisfactory	Not passed

In order to determine the rating of a student (listener) in the discipline $\mathbf{R_{dis}}$ (up to 100 points), the rating from the exam $\mathbf{R_{ex}}$(up to 30 points) is added to the rating of a student's academic work $\mathbf{R_{aw}}$ (up to 70 points): $\mathbf{R_{dis} = R_{aw} + R_{ex}}$ **.**

11. Educational and methodological support.

All methodological support - lecture material, description of laboratory works and tasks for independent work are available on electronic media and in electronic training

courses: for the full term of training - (https://elearn.nubip.edu.ua/course/view.php?id=2805)., to which students of this specialty are enrolled.

Students learn informational material that is sufficiently covered in educational literature on their own. There is a sufficient amount of recommended literature in the library of NULES of Ukraine.

12. Recommended sources of information

1.Фізика : підручник для вищих навчальних закладів / Бойко В.В., Булах Г.І.; Гуменюк Я.О., Ільїн, П.П. Національний університет біоресурсів і природокористування України. – К.: "Ліра-К", 2019. – 468 с.

2.Бойко В.В., Булах Г.І., Гуменюк Я.О., Ільїн П.П.; Сукач Г.О. Фізика : Частина ІІ. Електромагнетизм. Електромагнітні коливання та хвилі. Оптика. Елементи квантової фізики, фізики твердого тіла, атома та ядра. навчальний посібник для студентів нефізичних спеціальностей ВНЗ / за ред. В. В. Бойка ; Національний університет біоресурсів і природокористування України. – К. : ВЦ "АЗБУКА", 2020. – 319 с.

3.Біофізика : підручник для студентів вищих навчальних закладів ІІІ-ІV рівнів акредитації / Посудін Ю.І.; Бойко В.В.; Годлевська О.О.; Залоїло І.А. Національний університет біоресурсів і природокористування України. - К. : Ліра-К, 2020. - 704 с.

4.Навчальний посібник «Практикум з біофізики. Ч.1» (Бойко В.В., Залоїло І.А., Годлевська О.О., Посудін Ю.І.), Національний університет біоресурсів і природокористування України. - К. : Ліра-К, 2021. - 570 с.

5.Годлевська О.О. Методичні вказівки до виконання лабораторно-практичних робіт «Основи біофізики» для студентів вищих аграрних навчальних закладів ІІІ-ІV рівнів акредитації з напрямів «Екологія та охорона навколишнього середовища», «Екобіотехнологія», «Захист рослин» 2020,-160 стор.

6.V. Boyko, O. Godlevska, P. Iliin, M. Malyuta."Physics". Methodical recommendations for the students, who attend the English-speaking lectures.-2022, printed NULE of Ukraine, Kyiv , p.52.

7. V.Boyko, P.Iliin, O.Godlevska Навчально-методичні рекомендації: Methodical recommendations for performing laboratory work remotely who attend the English-speaking lectures, 2023, printed NULE of Ukraine, Kyiv ,p. 247.

Інтернет - джерела

1. Канал Youtube «КАФЕДРА ФІЗИКИ НУБіП УКРАЇНИ» https://www.youtube.com/channel/UCUQ-x3dx5Lw2SL6w9a6DNDg. Дата звернення: 20.03.2023

2. Механіка. Основні поняття.
URL: https://www.youtube.com/watch?v=hyEul6F8baw
Дата звернення: 20.05.2023

3. Молекулярна фізика. Початок термодинаміки.
URL: https://www.youtube.com/watch?v=fo2HE2tu_3I
Дата звернення: 20.05.2023
4. Електростатика. Електроємність. Конденсатори.
URL: https://www.youtube.com/watch?v=37E2Gc73HaA
Дата звернення: 20.05.2023
5. Магнетизм. Основи. Електрична і магнітна взаємодії. Індукція магнітного поля.
URL: https://www.youtube.com/watch?v=_jReBOzCFLI
Дата звернення: 20.05.2023
6. Оптика. Основні положення.
URL: https://www.youtube.com/watch?v=v64Vq_k-yHo
дата звернення: 20.05.2023

7. Портал: Фізика – Вікіпедія
URL: https://uk.wikipedia.org/wiki/Портал:Фізика
дата звернення: 20.05.2023