NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Physics DEPARTMENT

APPROVED
Faculty (Institute)_____
Plant Protection,
Biotechnology and Ecology
(назва)
"_5_" 06 2025

PROGRAM OF THE COURSE

Mathematics and physics (physics)

Specialization _____G21 "Biotechnologies and bioengineering"

Educational program _____ "Biotechnologies and bioengineering"

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

Kyiv – 2025

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

Field of knowledge, specialization, educational program, educational degree		
Educational degree	*Bachelor's*	
Specialization	G21 "Biotechnologies and bioengineering"	
Educational program	Biotechnologies and bioengineering	
Characteristics of the course		
Type	Compulsory	
Total number of hours	105	
Number of ECTS credits	3.5	
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	-	
Laboratory classes	30 hr.	
Self-study	60	
Individual assignments	-	
Number of weekly classroom hours for the full-time form of study	3hr.	

Purpose, objectives, and competencies of the course

The discipline " Physics" is one of the main parts of the theoretical training of bachelors in the specialty G21 "Biotechnologies and bioengineering", 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.

GK10 Ability to evaluate and ensure the quality of performed works.

professional (special) competences:

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

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

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.

The structure of the scientific discipline

Names of content modules and topics	Number of hours											
	full-time form						Part-time form					
	total	including					total	including				
		l	p	lab	ind	self		l	p	lab	ind	self
1	2	3	4	5	6	7	8	9	10	11	12	13
Content module 1. Mechanics. Molecular physics.Thermodynamics.												
Topic 1. Kinematics and dynamics of a material point.	6	2		2		8						
Topic 2. Work and energy.	8	2		4		8						
Topic 3. Dynamics of rotary motion.	8	2		4		8						
Topic 4. Molecular kinetic theory of ideal gases and thermodynamics.	10	2		6		6						
Content module 2. Electricity. Magnetism. Optics.												
Topic 5. Electrostatics and Direct current	6	2		2		6						
Topic 6. Magnetic field.. The phenomenon of electromagnetic induction	8	2		4		6						
Topic 7. Harmonic oscillations. Waves.	8	2		4		8						
Topic 8. Physics of the atom and atomic nucleus.						10						
Total hours	**60**	**15**		**30**		**60**						

Laboratory class topics

№	Topic title	Number of hours
1.	Statistical calculations (error, significant figure, rounding).	2
2.	Lab. work 1-1. Determining the acceleration of free fall using a mathematical pendulum	2
3.	Lab. work 1-3. Determination of the moment of inertia of a torsional pendulum.	
4.	Lab. work 1-4. Determination of Young's modulus of elastic substances	2
5.	Lab. work 2-1. Determination of the rate of sedimentation of bodies and the coefficient of internal friction of a liquid by the Stokes method	2
6.	Lab. work 2-3. Determination of the surface tension of a liquid by the droplet separation method.	
7.	Lab. work 2-2. Determination of the ratio of specific heat capacities C_p/C_V of gas by the method of adiabatic expansion (Clément-Desormes method).	2
8.	Control from module 1	2
9.	Lab. work 3-1. Study of the electrostatic field	2
10.	Lab. work 4-1. Determination of the specific charge of an electron using the magnetron method.	2
11	Lab. work 4-2. Determination of the horizontal induction component of the Earth's magnetic field.	2
12.	Lab. work 5-1. Determination of refractive indices using a microscope	2
13.	Lab. work 5-7. “Test of Malus's law”	2
14.	Lab. work 5-6. Determination of the wavelength of light using a diffraction grating	2
15.	Control from module 2	2

Self-study

№	Topic title	Number of hours
1	Processing of lecture material	15
2	Preparation for laboratory classes	20
3	Preparation for control works (testing)	25

Teaching methods.

The following teaching methods are used when teaching the discipline:

1. Lecture.

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

Assessment of learning outcomes.

The knowledge of a higher education applicant is assessed on a 100-point scale and is converted into a national assessment in accordance with the current "Regulations on Examinations and Tests at the NULES of Ukraine"

Distribution of points by types of educational activities

Type of educational activity	Learning outcomes	Evaluation
Module 1. Mechanics. Acoustics. Thermodynamics.		
Statistical calculations (error, significant figure, rounding).	Report	**10**
Determining the acceleration of free fall using a mathematical pendulum	Report	**10**
Determination of Young's modulus of elastic substances	Report	**10**
Test task	Answers to questions	**10**
Determination of the ratio of specific heat capacities C_p/C_V of gas by the method of adiabatic expansion (Clément-Desormes method).	Report	**10**
Determination of the surface tension of a liquid by the droplet separation method.	Report	**10**

Determination of entropy change during melting of tin.	Report	**10**
Determination of the wavelength of light using a diffraction grating	Report	**10**
Modular test 1	Answers to questions	**20**
Total by module 1		**100**
Module 2. Electricity. Magnetism. Optics.		
Study of the electrostatic field	Report	**10**
Determination of the electromotive force of the current source by the compensation method	Report	**10**
Determination of the specific charge of an electron using the magnetron method.	Report	**10**
Determination of the horizontal induction component of the Earth's magnetic field.	Report	**10**
Determination of refractive indices using a microscope	Report	**10**
Determination of the wavelength of light using a diffraction grating	Report	**10**
Determination of Planck's constant by the Lukyrskyi method.	Report	**10**
Modular test 2	Answers to questions	**30**
Total by module 2		**100**
Educational work		**(M1 + M2)/2*0,7 ≤ 70**
Exam		**30**
Total per course		**(Educational work + Exam) ≤ 100**

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.

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"

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): $\mathbf{R_{dis} = R_{aw} + R_{ex}}$ **.**

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=3659

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.

Recommended sources of information

V. Boyko, , P. Ilyin, O. Godlevska. *Physics. Навчальний посібник для студентів, що слухають лекції англійською мовою.* Київ, Ліра-К, 2024-286с.

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V. Boyko, O. Godlevska, P. Iliin, M. Malyuta."Physics". Methodical recommendations for the students, who attend the English-speaking lectures.-2022, 51стор.

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. Бойко В.В., Відьмаченко А.П., Залоїло І.А., Малюта М.В. Фізика з основами кваліметрії: Навчальний посібник. - К.: Видавництво «Ліра– К», 2018, – 564 с.

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Бойко В.В., Відьмаченко А.П., Ільїн П.П., Гуменюк Я.О., Чорній В.П., Малюта М.В. Методичні вказівки до виконання лабораторних робіт з фізики. Частина 1. // К.:, Видавничий центр НУБіП України. 2017. -86 с.

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

3. Молекулярна фізика. Початок термодинаміки.
URL: https://www.youtube.com/watch?v=fo2HE2tu_3I

4. Електростатика. Електроємність. Конденсатори.
URL: https://www.youtube.com/watch?v=37E2Gc73HaA

5. Магнетизм. Основи. Електрична і магнітна взаємодії. Індукція магнітного поля.
URL: https://www.youtube.com/watch?v=_jReBOzCFLI

6. Оптика. Основні положення.
URL: https://www.youtube.com/watch?v=v64Vq_k-yHo

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