Appx 2

to the Order of March 23, 2023 № 244

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

"**CONFIRMED**"
Dean of the Faculty of Plant Protection,
Biotechnology and Ecology
_____ Yulia Kolomiets
"___"_____2023 year.

"**APPROVED**"
at the meeting of the department__Physics_____
Protocol №_5_ dated "_29__" _of May___2023 year.
Head of Department
_____(Volodymyr Boyko)

"**REVIEWED** "
Program Coordinator_____
_____
Program Coordinator
_____ Oksana Klyachenko

PROGRAM OF THE COURSE

Physics

Specialization _____162 "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 – 2023

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

Field of knowledge, specialization, educational program, educational degree		
Educational degree	*Bachelor's*	
Specialization	Biotechnologies and bioengineering	
Educational program	Biotechnologies and bioengineering	
Characteristics of the course		
Type	Compulsory	
Total number of hours	120	
Number of ECTS credits	4	
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	30 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	4hr.	

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

The discipline " Physics" is one of the main parts of the theoretical training of bachelors in the specialty162 "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.

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).

Lecture 3.

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 4.

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.

Lecture 5.

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 6.

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 7.

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.

Lecture 8.

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 9.

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.

Lecture 10.

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 11.

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.

Lecture 12.

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.

Lecture 13.

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.

Lecture 14.

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

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.

Natural and polarized light. Malus' law. Brewster's Law. Double refraction.

Lecture 15.

TOPIC 2.6. Physics of the atom and atomic nucleus.

Rutherford's model of the atom. Emission spectra of atoms. Bohr's postulates. The composition of the nucleus, protons and neutrons. Isotopes. Nuclear forces. Mass defect and nuclear binding energy.

The phenomenon of radioactivity. Composition of radioactive radiation. Basic properties of alpha and beta decays. Law of radioactive decay. Nuclear reactions. Fission of heavy nuclei and nuclear fusion as a source of energy.

3. 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 and thermodynamics. Electrostatics and direct electric current												
Topic 1. Kinematics of a material point.	4	2				2						
Topic 2. Dynamics of a material point	8	2		2		4						
Topic 3. Work and energy.	8	2		2		4						
Topic 4. Dynamics of rotary motion.	8	2		2		4						
Topic 5. Molecular kinetic theory of ideal gases.	8	2		2		4						
Topic 6. Basics of thermodynamics.	8	2		2		4						
Topic 7. Electrostatics	8	2		2		4						
Topic 8. Direct current	8	2		2		4						
Content module 2. Magnetism. Oscillations and waves. Optics. Physics of the atom and atomic nucleus.												
Topic 9. Magnetic field..	8	2		2		4						
Topic 10. The phenomenon of electromagnetic induction	8	2		2		4						
Topic 11. Harmonic oscillations.	8	2		2		4						
Topic12. Waves.	8	2		2		4						
Topic 12. Geometric optics	8	2		2		4						
Topic 14 Waves optics	10	2		4		6						
Topic 15. Physics of the atom and atomic nucleus.	8	2		2		4						

Total hours	**120**	**30**		**30**		**60**						

4.Seminar topics

№	Topic title	Number of hours
1		
2		
...		

5.Practical class topics

№	Topic title	Number of hours
1		
2		
…		

6.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 1-2. Determination of Young's modulus of elastic substances	2
4.	Lab. work 1-3. Determination of the moment of inertia of a torsional pendulum.	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 2-2. Determination of the ratio of specific heat capacities C_p/C_V of gas by the method of adiabatic expansion (Clément-Desormes method).	2
7.	Lab. work 2-3. Determination of the surface tension of a liquid by the droplet separation method.	2

8.	Lab. work 2-4. Determination of entropy change during melting of tin.	2
9.	Lab. work 3-1. Study of the electrostatic field	2
10.	Lab. work 3-2. Determination of the electromotive force of the current source by the compensation method	2
11	Lab. work 4-1. Determination of the specific charge of an electron using the magnetron method.	2
12.	Lab. work 4-2. Determination of the horizontal induction component of the Earth's magnetic field.	2
13.	Lab. work 5-1. Determination of refractive indices using a microscope	2
14.	Lab. work 5-6. Determination of the wavelength of light using a diffraction grating	2
15.	5-8. Determination of Planck's constant by the Lukyrskyi method.	2

7.Independent work topics

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

8.Samples of control questions, tests for assessing the level of knowledge acquisition by students.

1.DYNAMICS OF MATERIAL POINT. (Definition of material point. First, second, third Newton's Law. Kind of forces in mechanics.)

2.Electric field. Coulomb's low. The Intensity of Electric Field. Graphic representation of Electric Fields. The Potential of the Electrostatic Field.

Closed single-choice tests (1 point each: 10 points in total)

	Question 1. What the formula corresponds to the Instantaneous Velocity ?		**Question 6. What the formula corresponds to the Hooke's Law?**
1	$\vec{a} = \frac{d\vec{\upsilon}}{dt}$	1	$\vec{F} = m\vec{a}$
2	$\langle\vec{a}\rangle = \frac{\Delta\vec{\upsilon}}{\Delta t}$	2	$F = -kx$
3	$\vec{\upsilon} = \frac{d\vec{r}}{dt}$	3	$F = 6\pi\eta rV$
2	$\langle\vec{\upsilon}\rangle = \frac{\Delta\vec{r}}{\Delta t}$	4	$\vec{F}_{21} = -\vec{F}_{12}$

	Question 2. What the expression corresponds to the Newton's Second Law?		**Question 7. What expression corresponds to the definition of work?**
1	Every particle in the universe attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them	1	$V = \frac{2g}{9}\frac{\rho-\rho_0}{\eta}R^2$
2	If two bodies interact, the force exerted on body 1 by body 2 is equal to and opposite the force exerted on body 2 by body 1	2	$A = \vec{F}\cdot\vec{s}$
3	The acceleration of an object is directly proportional to the resultant force acting on it and inversely proportional to its mass	3	$p + \frac{\rho\upsilon^2}{2} + \rho gh = const$
4	An object at rest will remain at rest and an object in motion will continue in motion with a constant velocity unless it	4	$SV = const$

	experiences a net external force (or resultant force		

	Question 3. What is the hydrodynamic pressure?		**Question 8. What the expression corresponds to the Ohm's Law?**
1	The ratio of force to area (*F/S*)	1	$\varepsilon = -\frac{d\Phi}{dt}$
2	The pressure required to balance the osmotic flow of water (RTC_A)	2	$\varepsilon = I(R+r)$
3	The potential energy per unit volume (ρgh)		$\sum_{i=1}^{n}\varepsilon = \sum_{i=1}^{n} I_i R_i$
4	The kinetic energy per unit volume ($\rho\upsilon^2/2$)	4	$\varepsilon = -L\frac{dI}{dt}$

	Question 4. Find the expression for Lorenz's Force		**Question 9. What the expression corresponds to the Second Rule of Kirchhoff?**
1	$F = \sigma l$	1	$\varepsilon = -\frac{d\Phi}{dt}$
2	$\vec{F} = I[\vec{l} \times \vec{B}]$	2	$\varepsilon = I(R+r)$
3	$\vec{F} = q[\vec{V} \times \vec{B}]$	3	$\sum_{i=1}^{n}\varepsilon = \sum_{i=1}^{n} I_i R_i$
4	$F = G\frac{m_1 m_2}{r^2}$	4	$\varepsilon = -L\frac{dI}{dt}$

	Question 5. Give the definition of Interference		**Question 10. What equation describe the capillarity?**
1	The property of electromagnetic waves, such as light, that describes the direction of their transverse electric field	1	$F = \sigma l$
2	The superposition of two or more waves resulting in a new wave pattern	2	$\Delta p = \pm 2\sigma/R$
3	The separation of a wave into spectral components with different wavelengths	3	$SV = const$
4	Phenomena associated with the	4	$p + \rho\upsilon^2/2 = const$

	apparent bending of light around the obstacles		

«Бланк тестових завдань»

9.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.

10. 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.

11.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 № 404 від 01.05.2023)

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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=3836, for a shortened term of induction - https://elearn.nubip.edu.ua/course/view.php?id=3659, 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

Posudin Yuriy. *Physics with Fundamentals of Biophysic*.- 2d edition.- Kyiv: Printline, 2014.- 209 p.

Physics\ V. Boyko, O. Godlevska, P.Iliin, M. Malyuta\\ Methodical recommendations for the students, who attend the English-speaking lectures, printed NULE of Ukraine, Kyiv. 2021, p.52

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Посудін Ю.І. Фізика з основами біофізики. Київ, Світ, 2003.-400 с.

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2. Механіка. Основні поняття.
URL: https://www.youtube.com/watch?v=hyEul6F8baw
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3. Молекулярна фізика. Початок термодинаміки.
URL: https://www.youtube.com/watch?v=fo2HE2tu_3I
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4. Електростатика. Електроємність. Конденсатори.
URL: https://www.youtube.com/watch?v=37E2Gc73HaA
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5. Магнетизм. Основи. Електрична і магнітна взаємодії. Індукція магнітного поля.
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