National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of General Physics

Mechanics and molecular physics. Electrostatics. Electromagnetism

Working program of basic discipline (Silabus)

Requisites for basic discipline	
Level of higher education	***First (bachelor's)***
Branch of knowledge	*10 Natural sciences*
Specialty	*163 Biomedical Engineering*
Educational program	*Biomedical Informatics*
Discipline status	*Normative*
Form of study	*full-time*
Year of preparation, semester	*1 course, spring semester*
The scope of discipline	*270 hours / 9 credits ECTS*
Semester control / Control measures	*Exam/ Test Work, Modular Test Work*
Lessons schedule	*According to the schedule on the site http://rozklad.kpi.ua/*
Language of instruction	*English*
Information about course leader / teachers	***Lecturer:*** *Ph.D., Khist V.V., khist2012@gmail.com* ***Practical:*** *Ph.D., Khist V.V.*
Course placement	*Platform «Sikorsky»*

Curriculum of the discipline

1. 1. Description of the discipline, its purpose, subject of study and learning outcomes

The purpose of the discipline *is to form students' competencies, skills and knowledge in the field of physics in relation to the fundamental concepts, laws and theories of classical and modern physics, which provides them with effective mastery of special disciplines and further use of new physical principles in information technology and computer sciences.*

The subject of the discipline *- laws, methods and means of mechanics, electricity and magnetism, optics, physics of quantum phenomena, as well as atomic physics as components of the process of physical research.*

According to the requirements of the educational-professional program, students after mastering the discipline must demonstrate the following results:

CAPABILITIES

General competencies *(OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

GC 1 *- Ability to abstract thinking, analysis and synthesis.*
GC 2 *- Ability to search, process and analyze information from various sources.*
GC 3 *- Ability to identify, formulate and solve problems.*
GC 5 *- Ability to work in an international context.*

Special (professional) competencies *(OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

PC 1 *- Ability to solve complex problems of biomedical engineering using the methods of mathematics, natural and engineering sciences.*
PC 2 - *Ability to develop a working hypothesis, plan and set experiments to test the hypothesis and achieve the engineering goal using appropriate technologies, technical means and tools.*
PC 9 *- Ability to create tools and methodologies of scientific activity, evaluation and implementation of the results of modern developments, solutions and achievements of engineering and exact sciences in medicine and biology.*

The program learning outcomes after studying the discipline "Mechanics and molecular physics. Electrostatics. Electromagnetism" are *(OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):*

PLO 1 *- Know, understand and be able to apply at the basic level the basic principles of general and theoretical physics, in particular, classical, relativistic and quantum mechanics, molecular physics and thermodynamics, electromagnetism, wave and quantum optics, atomic physics and atomic nucleus to establish, analyze, interpretation, explanation and classification of the essence and mechanisms of various physical phenomena and processes for solving complex specialized problems and practical problems in physics and / or astronomy.*

PLO 7 *- Know the basic skills of theoretical and / or experimental research in certain special sections of physics or astronomy, performed individually (autonomously) and / or as part of a scientific group.*

PLO 9 - *Be able to apply basic mathematical knowledge used in physics and astronomy: analytical geometry, linear algebra, mathematical analysis, differential and integral equations, probability theory and mathematical statistics, group theory, methods of mathematical physics, theory of functions of complex variables, mathematical modeling.*

PLO 10 *- Be able to plan research, choose the best methods and means to achieve the goal of research, find ways to solve scientific problems and improve applied methods.*

PLO 11 *- Be able to organize, interpret and summarize the obtained scientific and practical results, draw conclusions.*

PLO 16 *- Be able to study independently and improve their skills.*

PLO 25 *- Be able to conduct theoretical or experimental research performed individually or as part of a research group.*

2. Prerequisites and postrequisites of the discipline (place in the structural and logical scheme of education according to the relevant educational program)

The value of the discipline in the training of specialists:

The course of general physics, together with the courses of higher mathematics and computer science, plays the role of a fundamental physical and mathematical base, without which the successful activity of a specialist in any field of technology is impossible. This program reflects the current state of teaching physics in higher technical educational institutions. It involves a natural combination of macroscopic and microscopic approaches and the disclosure of internal logical connections between different branches of physical science.

In the structural and logical scheme of the specialist-training program, the following disciplines and credit modules provide the credit module:

Name of credit module (discipline)	*Topics from RNP (names and numbers) or code for OPP, Providing a credit module.*	
1 / I Mathematical analysis	*Differential calculus of functions of one and several variables*	*MPN 2.01.01*
	Integral calculus of a function of one variable	*MPN 2.01.02*
	Multiple integrals	*MPN 2.01.05*
	Theory of function of a complex variable	*MPN 2.01.07*

The credit module in the structural and logical scheme of the training program provides the following disciplines and credit modules:

Name of credit module (discipline)
Theory of biomedical signals
Theory of automatic control

3. The content of the discipline

The main sections and topics that will be considered in the process of studying the course:

Section 1. "Mechanics and molecular physics. Electrostatics. Electromagnetism"

Partition 1. *Physical basis of mechanics*

Topic 1.1. Introduction. Kinematics.

Basic concepts, magnitudes and equations of kinematics of the material point. Rotational motion of a solid body. Flat motion of a solid body.

Topic 1.2. The dynamics of the translational motion.

Newton's laws. Basic equation of motion of a material point. Movement in non-inertial reference systems.

Topic 1.3. Momentum.

The position and movement of the center of the masses of the system. The law of conservation of momentum.

Topic 1.4. Work and energy.

Work and power of force. Kinetic and potential energy. The connection between mechanical energy and the work of forces. The law of conservation of mechanical energy. Simultaneous energy and momentum conservation.

Topic 1.5. Dynamics of rotational motion of a solid.

Moment of momentum and moment of inertia. The equation of the dynamics of the rotational motion of a solid. Saving the momentum to the axis. Calculation of moments of inertia of solids

Topic 1.6. Mechanical oscillations.

Equation of mechanical oscillations.

Topic 1.7. Elements of the special theory of relativity

The transformation of Lorentz and the consequences of them. Relativistic law of speed transformation. Limit of the velocity C. Relativistic momentum. Equation of relativistic particle movement.

Section 1. Electricity and Magnetism.

Topic 2.1. Electrostatic field in vacuum.
Electric field tension. Electrostatic potential of the electric field. The electrostatic theorem of Gauss. Electric dipole.
Topic 2.2. Electrostatic field in matter.
Electric field in dielectrics and conductors. Electrical capacity. Energy of the electric field.
Topic 2.3. Direct current laws.
Size and current density, current line. The laws of Oma and Joule-Lentz in the local (differential) form. External forces, voltage drop and electromotive force (EMF). Ohm's law for any stake.
Topic 2.4. Magnetic field.
Magnetic interaction, vector of magnetic induction. Magnetic field of conductor with current, the law of Bio-Savar. Magnetic fields of the simplest systems. The effect of the magnetic field on the current, Ampere law. Circuit with current in external magnetic field. Basic equations of magnetostatics in a vacuum: the Gauss integral theorem and the theorem on the circulation of the magnetic field of strings. The nature of the magnetism of matter. Magnetization and magnetization. Magnetization of an isotropic magnet, magnetic susceptibility and permeability. Magnetic field tension vector. Theorem on the circulation of a magnetic field in a substance.
Topic 2.5. Electromagnetic induction.
The phenomenon of electromagnetic induction. Rule of Lenz. Faraday's Law. Conductor inductance, self-induction. Magnetic energy. Vortical electric field. Displacement current. The law of in-stream current. Maxwell's system of equations in integral and differential forms. Fundamental-material and material equations. Electromagnetic waves.

Section 4. Molecular Physics.
Topic 3.1 Fundamentals of the molecular-kinetic theory of ideal gas.
Molecular physics and thermodynamics, their tasks and methods. Macroscopic parameters and their microscopic interpretation. Laws of ideal gases. Equation of the state of ideal gas. The basic equation of the molecular-kinetic theory of gas. Temperature.
Topic 3.2. Fundamentals of thermodynamics.
Internal energy of the thermodynamic system. Heat, work, heat capacity. The first law of thermodynamics. Isoprocesses of ideal gas: isochoric, isobaric, isothermal, adiabatic processes. Circular processes. Carnot cycle and its efficiency. Clausius's inequality. Entropy and its properties. The second law of thermodynamics. Internal energy, Helmholtz energy, potential Gibbs, enthalpy. Nerst's theorem
Topic 3.3. Real gases. Liquids Crystals.
Distribution of energy by degrees of freedom. Transition phenomena in gases. General properties and structure of liquids. Viscosity. Surface tension. Wetting and capillary phenomena. The main characteristics of crystals. Force of communication in solids. Defects Thermal expansion of solids. Heat capacity of solids.
Topic 3.4. Phases Phase transformation.
Phase transitions of type I and II.

4. Training materials and resources

Basic literature:

1. Kucheruk I.M., Gorbachuk I.I., Lutsyk P.P. General course of physics. Mechanics, molecular physics and thermodynamics. - K: Technica, 1999.

2. Kucheruk I.M., Gorbachuk I.I., Lutsyk P.P. General course of physics. Electricity and magnetism. - K: Technica, 2001.
3. Saveliev IV The course of general physics, vols. 1. -M. : Nauka, 1982.
4. Saveliev IV The course of general physics, vols. 2. -M. : Nauka, 1982.
5. Irodov I. E. Problems in general physics. – M.: Nauka, 1987 or SPb .: Lan' 2001.

Additional literature:

6. Sivukhin DV The general course of physics. - M.: Nauka, 1977 - 1986, vol. 1.
7. Sivukhin DV The general course of physics. - M.: Nauka, 1977 - 1986, vol. 3.
8. Matveev AN Mechanics and the theory of relativity. - M .: Vyschaya Shkola, 1986.
9. Matveev AN Electricity and magnetism. - M .: Vyschaya Shkola, 1983.
10. Irodov I.E. Mechanics Basic Laws. - M: Laboratory of Basic Knowledge, 2000.
11. Irodov I.E. Electromagnetism. Basic Laws. - M: Laboratory of Basic Knowledge, 2002.
12. Methodological guidelines for laboratory work No. 4 (1) "Study of the dynamics of the simplest systems using the Atwood machine" from the section "Mechanics" of the general physics course. Yakunina N.O., Fedotov V.V., Yurchenko I.O. - K .: NTUU "KPI", 2006 - 12 pp.
13. Methodological instructions for laboratory work № 6 (1) "Determination of moments of inertia of bodies by the method of a trifiline suspension" from the section "Mechanics" of general physics course / Yakunina N.O., Yurchenko I.O., Fedotov V.V. - K .: NTUU "KPI", 2006 - 16 p.
14. Methodological instructions for laboratory work No. 7 (1) "Studying the rotational motion of a solid and determining the velocity of a ball with a torsion ballistic pendulum" from the section "Mechanics" of general physics. Yakunina N.O., Yurchenko I. O., Fedotov V.V. - K .: NTUU "KPI", 2006 - 12 p.
15. Cherkashin VP Laboratory Practicum on Physics (Electricity and Magnetism). - K: Vyscha Shkola, 1988.
16. Berkeley Physics Course. - M: Nauka, 1975 - 1977, Vol. 1.2
17. Feynman R., Leighton R., Sands. Feynman lectures on physics. - M: Mir, 1977.
18. Firgant E.V. Guide to solving problems in the course of general physics.
19. Belikov B. S. Solution of problems in physics. - M .: Vyschaya Shkola, 1986.
20. "Electric field of charges in a vacuum". Terms of tasks for the design work / compilers Assoc. Briginets VP, Assoc. Guseva O.O.
21. Molecular physics. Methodical instructions for laboratory work in physics. – K.: publisher "Pugach O.V.", 2009.-40 p.

Educational content

5. Methods of mastering the discipline (educational component)

The educational part of the discipline consists of lecture material, practical and laboratory classes and control activities. When teaching the course, it is recommended to build students' familiarity with the subject so that they not only receive information about the course being studied, but also feel the connection between different topics of the credit module, as well as the place of the module among other physical disciplines. The general methodological approach to teaching the discipline is defined as communicative-cognitive and professional-oriented, according to which the center of the educational process is the student - the subject of study and the future specialist.

Lections

Lection № 1	***Kinematics of the material point***
	Introduction. Mechanical motion. Reference frame Subject mechanics. Kinematics and dynamics. Models of classical mechanics: material point (particle), system of material points, absolutely solid body. Relativistic and quantum mechanics.
Literature	*[1], 1.1, 1.3,1.4;* *[3], 1-4* *[10], 1.1.*
Lection № 2	***Kinematics of the material point***
	Kinematic description of the movement. Trajectory, path and movement, speed and acceleration. General equations of kinematics of the material point.
Literature	*[1], 1.1, 1.3,1.4;* *[3], 1-4* *[10], 1.1.*
Lection № 3	***Kinematics of a solid***
	Tangential, normal and complete acceleration. *Progressive, rotational and flat motion of a rigid body. Angular displacement, angular velocity and angular acceleration. The connection between angular and linear values.*
Literature	*[1], 1.2, 1.5, 1.6;* *[3], 5*
Lection № 4	***Basic laws of classical dynamics. Non-inertial reference frameworks***
	Inertial reference systems. Strength and weight. The basic equation of the motion of a classical particle *Non-inertial reference frameworks. Description of motion in non-inertial reference systems. Inertia forces. Inertia forces in rotating reference systems*
Literature	*[1], 2.3, 2.4;* *[3], 6-17* *[1], 8.1 – 8.4;* *[3], 32-35.*
Lection № 5	***The law of conservation of momentum. Center of mass***
	The momentum of the material point and system, the connection between momentum and force. The law of conservation of momentum. Center of the masses of the system, the law of the movement of the center of masses.
Literature	*[1], 2.3, 2.5;* *[3], 8, 18, 27, 28*
Lection № 6	***Work and power of force. Potential energy. The law of***

	conservation of mechanical energy
	Work and power of force. Work of variable power. Kinetic energy of a point and a mechanical system. Conservative forces. Potential energy of a point and a mechanical system. The connection between the potential energy and the force. Non-conservative and dissipative forces, the work of dissipative forces. Complete mechanical energy of the system. The connection between complete mechanical energy and the work of forces. The law of conservation of mechanical energy
Literature	*[1], 3.1 – 3.7;* *[3], 18–26*
Lection № 7	***Equation of moments. The moment of solid state inertia***
	Angular dynamic values. Moment of momentum and moment of force. Equation of moments for a particle and a particle system. The law of conservation of momentum momentum. *Moment of inertia. Calculation of moments of inertia of solids, Steiner's theorem, and other theorems that help to calculate the moment of inertia.*
Literature	*[1], 2.9;* *[3], 36-38* *[1], 4.1, 4.2;* *[3], 39*
Lection № 8	***Solid state dynamics***
	The equation of the dynamics of the rotational motion of a solid. Kinetic energy of the body in the rotational and flat motion of a solid.
Literature	*[1], 4.3, 4.4;* *[3], 38, 41*
Lection № 9	***Mechanical oscillations***
	Equation of free, attenuating, forced oscillations and analysis of their solutions. Oscillations of mathematical and physical pendulums. Adding oscillations using a vector diagram.
Literature	*[1], 10.1-10.11;* *[3], 49-61*
Lection № 10	***Postulates of the special theory of relativity. Kinematics of the special theory of relativity. Relativistic dynamics***
	The transformation of Galileo and the principle of the relativity of classical mechanics. Postulates of the special theory of relativity. The transformation of Lorentz and the consequences of them. Converting speeds. Speed limit with. Relativistic impulse. The equation of motion of a relativistic particle. Kinetic energy of a relativistic particle, Einstein's formula.
Literature	*[1], 1.1, 2.6, 9.1–9.8;* *[3], 62–71*
Lection № 11	***Electric field tension. Potential of electric field***

		Electric charge and electromagnetic field. Electric field, field strength vector. Point charge field. The principle of superposition *The difference in potentials and potential. Relationship between the potential and the strength of the electrostatic field.*
	Literature	*[2], 1.1, 1.5;* *[4], 1, 5.* *[2] 1.10, 1.11;* *[4], 6–8.*
Lection № 12		***Gauss electrostatic theorem. Electric dipole***
		Flow of the vector field. Integral and differential forms of the Gauss electrostatic theorem for a field in a vacuum. *Electric dipole. Potential and electric dipole tension. The force and moment of forces acting on an electric dipole in an external electric field.*
	Literature	*[2], 1.7;* *[4], 13, 14.* *[2], 1.6 ;* *[4], 9.*
Lection № 13		***Electric field in dielectrics and conductors***
		Dielectrics and conductors. Macroscopic field in matter. Polarization of dielectrics, polarization (bound) charges, polarization. Vector of electric displacement, Gauss theorem for an electric field in the presence of an insulator.
	Literature	*[2], 1.16, 1.20, 1.12, 1.13;* *[4], 15–25*
Lection № 14		***Electric field in dielectrics and conductors***
		Field in an isotropic dielectric, dielectric susceptibility and permeability. Conditions on the boundary between two dielectrics. *Conductor in an external electric field, electrostatic induction. Electric field of a charged conductor.*
	Literature	*[2], 1.16, 1.20, 1.12, 1.13;* *[4], 15–25*
Lection № 15		***Electrical capacity. Energy of the electric field***
		Electric capacitance, capacitors. Electrostatic energy. Localization of electrostatic energy, volumetric electric energy density.
	Literature	*[2], 1.14, 1.25, 1.26;* *[4], 26–30.*
Lection № 16		***DC laws. Electric circuits***
		Size and current density, current line. The laws of Oma and Joule-Lentz in the local (differential) form. *External forces, voltage drop and electromotive force (EMF). Ohm's law for any stake.*
	Literature	*[2], 2.1, 2.2, 2.4, 2.5;* *[4], 31, 32, 34, 37, 38.*

		[2], 2.3, 2.6, 2.7; *[4], 35, 36.*
Lection № 17	***Magnetic field of currents. Ampere's law. Flow and circulation of a magnetic field. Magnetic field in matter***	
	Magnetic interaction, vector of magnetic induction. Magnetic field of conductor with current, the law of Bio-Savar. Magnetic fields of the simplest systems. *The effect of the magnetic field on the current, Ampere's law. Circuit with current in external magnetic field.* *Basic equations of magnetostatics in a vacuum: the Gauss integral theorem and the theorem on the circulation of the magnetic field of currents.* *The nature of the magnetism of matter. Magnetization and magnetization. Magnetization of an isotropic magnet, magnetic susceptibility and permeability. Magnetic field tension vector* *Theorem on the circulation of a magnetic field in a substance.*	
	Literature	*[2], 8.1, 8.4;* *[4], 39, 40, 42.* *[2], 8.2, 8.3, 8.5–8.7;* *[4], 39, 41, 43–49.* *[2], 9.1, 9.2, 9.3;* *[4], 51.* *[2], 9.2;* *[4], 52–54.*
Lection № 18	***Electromagnetic induction. Magnetic field energy. Vortical electric field and bias current. Equation of electromagnetic field. Electromagnetic waves***	
	The phenomenon of electromagnetic induction. Rule of Lenz. Faraday's Law. Inductance contour, self-induction. Magnetic current energy. Localization of magnetic energy, energy density of a magnetic field. *Vortical electric field. Displacement current. The law of full current.* *Maxwell's system of equations in integral and differential forms. Fundamental and material equations. Electromagnetic waves*	
	Literature	*[2], 10.1, 10.2, 10.4, 10.6;* *[4], 60–68.* *[2], 13.1–13.4;* *[4], 69, 70* *[2], 13.4;* *[4], 71*

Practical classes

The main goals of the cycle of practical classes:
- consolidation of the assimilation of the content of the lecture material;
- assimilation of methods of analysis of physical phenomena;
- development of the ability to calculate physical quantities by analytical expressions;
- development of the ability to use mathematical apparatus for solving certain physical

№ 1	***Kinematics of the material point***	
	Basic concepts, magnitudes and equations of point kinematics	
	Literature	***№№ 1.1, 1.19, 1.23, 1.24***
	Tasks on the IWS	***№№ 1.20, 1.22, 1.25***
№ 2	***Kinematics of the material point***	
	Basic concepts, magnitudes and equations of point kinematics	
	Literature	***№№ 1.28, 1.29, 1.30***
	Tasks on the IWS	***№№ 1.26, 1.27, 1.35***
№ 3	***Kinematics of a solid***	
	Rotational motion of a rigid body	
	Literature	***№№ 1.38, 1.39***
	Tasks on the IWS	***№№ 1.37, 1.40, 1.41, 1.46***
№ 4	***Kinematics of a solid***	
	Flat motion of a rigid body.	
	Literature	***№№ 1.42, 1.53***
	Tasks on the IWS	***№№ 1.47, 1.52***
№ 5	***The basics of dynamics***	
	Newton's laws	
	Literature	***№№ 1.63***
	Tasks on the IWS	***№№ 1.62, 1.64***
№ 6	***The basics of dynamics***	
	Basic equation of motion of a material point.	
	Literature	***№№ 1.69***
	Tasks on the IWS	***№№ 1.67, 1.89***
№ 7	***The basics of dynamics***	
	Basic equation of motion of a material point. Movement in non-inertial reference systems	
	Literature	***№№ 1.84***
	Tasks on the IWS	***№№ 1.90, 1.92***
№ 8	***Momentum***	
	The law of conservation of momentum. *The position and movement of the center of the masses of the system*	
	Literature	***№№ 1.121, 1.122*** ***№№ 1.126, 1.127, 1.129***
	Tasks on the IWS	***№№ 1.112*** ***№№ 1.116***
№ 9	***Work and energy***	
	Work and power of force. Kinetic and potential energy. The connection between mechanical energy and the work of forces	
	Literature	***№№ 1.144, 1.147, 1.155***
	Tasks on the IWS	***№№ 1.139, 1.140***
№ 10	***Work and energy***	
	The law of conservation of mechanical energy. Simultaneous saving of energy and	

	momentum	
	Literature	***№№ 1.159, 1.176, 1.178, 1.183***
	Tasks on the IWS	***№№ 1.158***
№ 11	***Elements of solid body dynamics***	
	Calculation of moments of inertia of solids	
	Literature	***№№ 1.256*** ***№№ 1.260***
	Tasks on the IWS	***№№ 1.257*** ***№№ 1.281, 1.282***
№ 12	***Elements of solid body dynamics***	
	Moment of momentum and moment of inertia. The equation of the dynamics of the rotational motion of a solid. Saving the momentum to the axis	
	Literature	***№№ 1.198, 1.268*** ***№№ 1.278, 1.290***
	Tasks on the IWS	***№№ 1.195, 1.207, 1.262, 1.263*** ***№№ 1.266, 1.267, 1.280***
№ 13	***Mechanical fluctuations.*** ***Fundamentals of the special theory of relativity*** ***MCW-1***	
	Equation of mechanical oscillations *The transformation of Lorentz and the consequences of them. Relativistic law of velocity transformation. Speed limit with. Relativistic impulse. The equation of motion of a relativistic particle* *Module control work for partition 1. Physical basis of mechanics*	
	Literature	***№№ 4.1, 4.3*** ***Lecture notes and practical exercises***
	Tasks on the IWS	***№№ 4.4, 4.7*** ***№№4.13, 4.24*** ***№№ 4.11, 4.14, 4.47*** ***№№ 1.364, 1.366, 1.369, 1.380, 1.384*** ***№№ 1.370, 1.372, 1.373, 1.385***
№ 14	***Electrostatic field in vacuum***	
	Calculation of the intensity and potential of the electric field of discrete and continuous charge distributions by the superposition principle and through the connection between stress and potential.	
	Literature	***№№ 3.9, 3.12, 3.16, 3.18, 3.35, 3.36, 3.48***
	Tasks on the IWS	***№№ 3.8, 3.13, 3.14, 3.28, 3.31, 3.34***
№ 15	***Electrostatic field in vacuum***	
	Calculation of spherical, cylindrical, and plane symmetric electric fields using the Gauss theorem	
	Literature	***№№ 3.22***
	Tasks on the IWS	***№№ 3.23, 3.25, 3.26***
№ 16	***Electrostatic field in vacuum***	
	Poisson equation. Electric dipole	
	Literature	***№№ 3.51***
	Tasks on the IWS	***3.50 ,3.49, 3.42, 3.43, 3.46***
№ 17	***Electrostatic field in matter***	
	Electric field in dielectrics.	

	Literature	***№№ 3.74, 3.96***
	Tasks on the IWS	***№№ 3.78, 3.85***
№ 18	***Electrostatic field in matter***	
	Conductors in the electric field. *Power consumption. Capacitors* *Energy of the electric field.*	
	Literature	***№№ 3.58, 3.104, 3.138***
	Tasks on the IWS	***№№ 3.59, 3.64, 3.103, 3.105, 3.106, 3.137, 3.139, 3.140, 3.143.***
№ 19	***Direct electrical current***	
	Characteristics and laws of electric current. Calculation of electric circuits of direct current	
	Literature	***№№ 3.156, 3.157, 3.181, 3.183***
	Tasks on the IWS	***№№ 3.169, 3.174, 3.175, 3.176, 3.177***
№ 20	***Magnetic field in vacuum***	
	Calculation of magnetic fields of currents by means of the Bi-Savar law and circulating theorems	
	Literature	***№№ 3.224, 3.225***
	Tasks on the IWS	***№№ 3.221, 3.227, 3.234, 3.241, 3.250, 3.251, 3.256, 3.260, 3.261a.***
№ 21	***Magnetic field in matter***	
	Calculation of the magnetic field in the substance. Determination of the Ampere force acting in a magnetic field on currents of different configurations	
	Literature	***№№ 3.290***
	Tasks on the IWS	***№№ 3.281, 3.282, 3.284, 3.285, 3.291, 3.294, 3.295.***
№ 22	***Electromagnetic induction***	
	Determination of the EMF and the direction of induction current according to the basic law of electromagnetic induction. Calculation of contour inductance. Electromagnetic oscillations	
	Literature	***№№ 3.299, 3.302, 3.309, 3.320***
	Tasks on the IWS	***№№ 3.300, 3.303, 3.304, 3.305, 3.324, 3.327, 3.334, 3.338, 3.351***
№ 23	***Maxwell's equation*** ***MCW-2***	
	Application of the integral and differential form of the Maxwell equations. *Modular control work for partition 3. Electricity and Magnetism and from Section 4. Electromagnetism. Fluctuations and waves*	
	Literature	***№№ 3.317*** ***Lecture notes and practical exercises***
	Tasks on the IWS	***№№ 3.363, 3.364, 3.365, 3.366, 3.370, 3.371, 3.372***
№ 24	***Fundamentals of the molecular-kinetic theory of ideal gas***	
	Boltzmann distribution (discussion of theoretical questions and experiment modeling)	
	Literature	***[21]***
	Tasks on the IWS	***Prepare an abstract on the questions of the program from the section.*** ***Prepare a protocol for laboratory work with answers to control questions***
№ 25	***Fundamentals of thermodynamics***	
	Determination of the ratio of heat capacity of gas at constant pressure to its specific heat at constant volume (discussion of theoretical questions and modeling of the experiment)	
	Literature	***[21]***

	Tasks on the IWS	***Prepare an abstract on the questions of the program from the section.*** ***Prepare a protocol for laboratory work with answers to control questions***
№ 26	***Real gases. Liquids Crystals***	
	Study of the laminar flow of gas through thin pipes (discussion of theoretical questions and simulation of the experiment)	
	Literature	***[21]***
	Tasks on the IWS	***Prepare an abstract on the questions of the program from the section.*** ***Prepare a protocol for laboratory work with answers to control questions***
№ 27	***Real gases. Liquids Crystals***	
	Determination of the viscosity coefficient of a fluid by the Stokes method (discussion of theoretical questions and simulation of the experiment)	
	Literature	***[21]***
	Tasks on the IWS	***Prepare an abstract on the questions of the program from the section.*** ***Prepare a protocol for laboratory work with answers to control questions***

Laboratory works

The main tasks of the cycle of laboratory works:
The main tasks of laboratory lessons from this credit module:
- consolidation of the assimilation of the content of the lecture material;
- assimilation of methods of analysis of physical phenomena;
- development of the ability to experiment with physical phenomena;
- development of the ability to calculate physical quantities by analytical expressions;
- development of the ability to apply a mathematical device for the study of certain physical phenomena.

№	*Name of laboratory work*	*Number of hours*
1	*Introduction, safety precautions when performing laboratory work. Measurement of physical size and processing of the obtained results.*	***2***
2	*Investigation of the dynamics of the simplest systems using the Atwood machine.*	***2***
3	*Determination of moments of inertia of bodies by the method of a trifiline suspension.*	***2***
4	*Investigation of the rotational motion of a solid and determining the speed of the ball with the help of a torsion ballistic pendulum.*	***2***
5	*Colloquium of laboratory lessons*	***2***
6	*Study of electrostatic field.*	***2***
7	*Removal of the magnetization curve and the hysteresis loop of ferromagnets in variable magnetic fields.*	***2***

8	*Investigation of free dip oscillations in the contour.*	***2***
9	***Colloquium of laboratory lessons***	***2***

6. Independent student work

The student's independent work is the main means of mastering the study material in his free time and includes:

№	*Type of independent work*	*Number hours*
1	*Preparation for classroom classes*	*36*
2	*Preparation for modular control work*	*6*
3	*Exam preparation*	*30*
	Total	*72*

Policy and control

7. Policy of academic discipline (educational component)

Attending classes

Attendance at lectures is optional. Attending practical classes is desirable, as they are used to write express tests / tests, as well as to defend practical work.

The grading system is focused on obtaining points for student activity, as well as performing tasks that are able to develop practical skills and abilities.

Control measures missed

Missed control measures (defense of practical work) must be practiced in the next classes, if the task is scheduled for the current lesson, or in consultations.

Omissions of writing a module test and express test are not fulfilled.

Calculation and graphic work, which is submitted for inspection in violation of the deadline, is evaluated with a decrease in the number of weight points.

Violation of deadlines and incentive points

Encouragement points		*Penalty points **	
Criterion	*Weight points*	*Criterion*	*Weight points*
Improving practical work	*1 points (for each practical work)*	*Untimely implementation and test of practical work*	*From -0.5 points to -5 points (depending on the delivery date)*
Passing distance courses on topics that are agreed with teachers	*5 points*	*Untimely execution and test of calculation and graphic work*	*From -2 points to -20 points (depending on the construction period)*
Registration of scientific work for participation in the competition of student scientific works	*10 points*		
Writing abstracts, articles, participation in international,	*5 points*		

national and / or other events or competitions on the subject of the discipline			

** if the control measure was missed for a good reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued.*

Academic integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Norms of ethical behavior

Normative principles of behavior of students and employees, defined in sections 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

The student has the right to appeal the results of the control measure according to the approved provision on appeals in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (approved by the order №NON/128/2021 from 20.05.2021) - https://osvita.kpi.ua/index.php/node/182

Inclusive education

The discipline "Mechanics and molecular physics. Electrostatics. Electromagnetism" can be taught to most students with special educational needs, except for students with severe visual impairments who do not allow to perform tasks using personal computers, laptops and / or other technical means.

Distance learning

Distance learning takes place through the Sikorsky Distance learning Platform «Sikorsky».

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The teacher offers the list of courses after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Performance of practical works, and performance of settlement and graphic work, is carried out during independent work of students in a remote mode (with a possibility of consultation with the teacher through e-mail, social networks).

Learning a foreign language

Teaching in English is carried out only for foreign students.

At the request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

8. Monitor and evaluate the system of evaluation of learning outcomes (Rating System of Evaluation)

Types of control:
Current control: Modular Test Work, Final Test Work.

Calendar control: *conducted twice a semester as a monitoring of the current state of compliance with the requirements of the syllabus.*

Semester control: *exam.*

Conditions of admission to the semester control: *successful completion of all control works, semester rating not less than 30 points.*

In the first lesson, students get acquainted with the rating system of assessment (RSA) of the discipline, which is based on the "Regulations on the system of assessment of learning outcomes", https://document.kpi.ua/files/2020_1-273.pdf.

Rating system for assessing learning outcomes

1. Profile competence in the study of physics of technical profile can be determined by three levels.

• A high level of profile competence is demonstrated by the ability to perform tasks that need to explain or predict phenomena based on their modeling, analyze the results of previous research, compare data, conduct scientific arguments to confirm their position, or evaluate different points of view.

• The average level of profile competence demonstrates the ability to use the acquired knowledge to explain or predict natural phenomena, to identify questions that could be answered by science, to provide information confirming the conclusions formulated by the task.

• Low level - tests the ability to update basic knowledge, facts, provide examples and use basic concepts to confirm the correctness of the already formulated conclusions.

Rating types of educational work

A student's rating in the RD discipline consists of the points he receives for:

1) Work in practical classes: n1 = 10

2) Performance and registration of n2 = 9 laboratory works, their defense at classes during the semester.

3) Execution of n3 = 1 modular control work.

4) Execution of n4 = 1 final test work

5) Answer the exam.

Rating points system and evaluation criteria

Laboratory workshop

Weight score for laboratory lesson r_{lc} = 5

0 points - no protocol of laboratory work failure to perform tests;

1-2 points - formal readiness for work, incomplete registration of the protocol, protection not at a high level (answers not to all questions, not enough complete answers, not understanding of the physical phenomena which are investigated in laboratory work), not performance of tests;

3-4 points - full design of the protocol (theoretical part, tables, calculations, graphs); defense of laboratory work at a high level (thorough answers to all questions), performance of tests for 60-70 points;

5 points - full design of the protocol (theoretical part, tables, calculations, graphs); protection of laboratory work at a high level (thorough answers to all questions)

The maximum total score for laboratory classes during the semester is:

$$n_1 * r_{lc} = 7*5 = 35$$

A student must complete all laboratory work curriculum.

Weight penalty point for untimely defense of laboratory work r = 2 points.

Work on practical classes: $n_2 = 10$

- Active creative work - 0.5 points;

- Fruitful work - 0.3 points;

- Passive work -0 points.

The maximum total score for practical classes during the semester is:

$$n_2 * r_{pc} = 10*0.5 = 5$$

Modular control (Modular Control Work)

Weight score for control work $r_{mcw} = 10$

0 points - no task is completed, or less than 30% of tasks are completed;

4 points - completed at least 30% of tasks;

7 points - completed at least 60% of tasks;

10 points - completed at least 90% of tasks.

The maximum total score for the test during the semester is:

$$n_3 * r_{vcw} = 10*1 = 10$$

Execution of the Final Test Work:

- Creative work - 15 points;

- The work was performed with minor shortcomings - 12 points;

- The work is done with certain errors - 10-8 points:

- Work is not credited (task not completed or there are gross errors) <5 points.

The maximum total score for the test during the semester is:

$$n_4 * r_{ftw} = 15*1 = 10$$

The examination component is 40% of the rating scale and is $R_E = 40$ points

Rating scale, final grade from the credit module.

The rating scale for the discipline R_D is formed from the total weight score for work in the semester:

$$R_D = n_1 * r_{lc} + n_2 * r_{pc} + n_3 * r_{mcw} + n_4 * r_{ftw} + R_E = 7{\cdot}5 + 10{\cdot}0.5 + 10{\cdot}1 + 10{\cdot}1 + 40 = 100 \text{ points}$$

The condition for admission to the exam is the successful completion of all tests, as well as a starting rating of at least 30 points.

In the exam, students solve two problems and give an oral answer to two theoretical questions. Each task in the ticket is evaluated in 10 points according to the following criteria:

- "Excellent", complete answer, not less than 90% of the required information (complete, error-free problem solving) - 20-17 points;

- "Good", a fairly complete answer, at least 75% of the required information or minor inaccuracies (complete solution of the problem with minor inaccuracies) - 16-13 points;

- "Satisfactory", incomplete answer, not less than 60% of the required information and some errors (the task is performed with certain shortcomings) - 12-8 points;

- "Unsatisfactory", the answer does not meet the conditions for "satisfactory" - 0 points.

To objectively assess the student's knowledge, the teacher has the right to ask additional questions from the course program, which are not contained in the ticket.

Table of translation of rating points to grades on a university scale:

Number points	*Assessment on the university scale*
100-95	*Perfectly / Відмінно*
94-85	*Very good / Дуже добре*
84-75	*Good / Добре*
74-65	*Satisfactorily / Задовільно*
64-60	*Enough / Достатньо*
Less 60	*Unsatisfactorily / Незадовільно*
Admission conditions are not met	*Not allowed / Не допущено*

9. Additional information on the discipline (educational component)

- *The list of questions is given in the KPI Electronic Campus named after Igor Sikorsky and in the course folder on the Sikorsky platform.*
- *Certificates of distance or online courses on the subject can be credited subject to the requirements set out in the ORDER № 7-177 FROM 01.10.2020 "On approval of the provisions on recognition in the KPI. Igor Sikorsky learning outcomes acquired in non-formal / informal education.*

Work program of the discipline (syllabus):

Compiled by a senior lecturer, Ph.D., Khist V.V.

Approved by the Department of General and Experimental Physics and the Department of General and Theoretical Physics (minutes of the joint meeting of the departments № 1 from 22.06.2021), reorganized from 01.07.2021 into the Department of General Physics.

Approved by the Methodical Commission of the Faculty of Physics and Mathematics (protocol № _11_ from 23.06.2021)