Federal State Autonomous Educational Institution of Higher Education
"Russian Peoples' Friendship University named after Patrice Lumumba"

Academy of Engineering
(name of the main educational unit (POU) - developer of the EP HE)

COURSE SYLLABUS

PHYSICS
(name of discipline/module)

Recommended by the Didactic Council for the Education Field of:

27.03.04 CONTROL IN TECHNICAL SYSTEMS
(code and name of the area of training/specialty)

The course instruction is implemented within the professional education programme of higher education:

DATA ENGINEERING AND SPACE SYSTEMS CONTROL
(name (profile/specialization) EP HE)

2024

1. GOAL OF DISCIPLINE MASTERING

The discipline “Physics” is included in the bachelor’s program “Data Engineering and Space Systems Control” in the direction of 27.03.04 “Control in Technical Systems” and is studied in the 1st and 2nd semesters of the 1st year. The discipline is implemented by the Department of Mechanics and Control Processes. The discipline consists of 4 sections and 52 topics and is aimed at studying a logically substantiated physical picture of the world, an array of theoretical knowledge with natural objects and analogues, and basic concepts of modern physics.

The goal of mastering the discipline is to develop in students a system of scientific knowledge and general professional skills necessary for solving specific physical and mathematical problems, identifying the physical foundations of mathematical models, etc., creating favorable conditions for students’ self-development, and developing the ability to highlight the main thing when constructing mathematical models.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Physics" is aimed at developing the following competencies (parts of competencies) in students:

Table 2.1. List of competencies formed in students when mastering the discipline (results of mastering the discipline)

Cipher	Competence	**Indicators of Competency Achievement** (within this discipline)
GPC-1	Able to analyze professional tasks based on regulations, laws and methods in the field of natural sciences and mathematics	GPC-1.1 Has basic knowledge acquired in the field of mathematical and (or) natural sciences; GPC -1.2 Able to use them in professional activities; GPC-1.3 Has the skills to select methods for solving problems of professional activity based on theoretical knowledge;

3. PLACE OF DISCIPLINE IN THE STRUCTURE OF HE EP

Discipline "Physics" refers to the mandatory part of block 1 “Disciplines (modules)” of the educational program of higher education.

As part of the educational program of higher education, students also master other disciplines and/or practices that contribute to achieving the planned results of mastering the discipline “Physics”.

Table 3.1. List of components of EP HE that contribute to achieving the planned results of mastering the discipline

Cipher	Name of competency	Previous disciplines/modules, practices*	Subsequent disciplines/modules, practices*
GPC -1	Able to analyze professional tasks based on regulations, laws and methods in the field of natural sciences and mathematics		Research work / Scientific research work; Technological Training; Undergraduate practice / Pre-graduate practice; Space Flight Mechanics; complex analysis;

* - to be filled out in accordance with the competency matrix and SUP EP VO

** - elective disciplines/practices

4. SCOPE OF DISCIPLINE AND TYPES OF STUDY WORK

The total labor intensity of the "Physics" discipline is "6" credit units.

Table 4.1. Types of educational work by periods of mastering the educational program of higher education for full-time study.

Type of educational work	**TOTAL,**ac.ch.		**Semester(s)**	
			1	**2**
Contact work, ac.ch.	*105*		*54*	*51*
Lectures (LC)	35		18	17
Laboratory work (LR)	35		18	17
Practical/seminar sessions (SZ)	35		18	17
Independent work of students, ac.ch.	*66*		*36*	*thirty*
Control (exam/test with assessment), academic degree.	*45*		*18*	*27*
Total labor intensity of the discipline	**ac.ch.**	***216***	*108*	*108*
	credit units	***6***	*3*	*3*

5. CONTENT OF DISCIPLINE

*Table 5.1. Containing*division of the discipline (module) by type of academic work

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
Section 1	Mechanics	1.1	Kinematics of a material point. Mechanical movement. Material point. Reference system. Rectilinear and curvilinear, uniform and variable movement. Speed, displacement, path, trajectory, acceleration. Normal and tangential acceleration.	LC, LR, SZ
		1.2	Dynamics of a material point and a system of material points. Newton's first law. Inertial reference systems. Mass and momentum. Newton's second law in differential form. Force as a derivative of impulse. Newton's third law. System of material points; center of mass and momentum of the system. Theorem on the motion of the center of mass. Law of conservation of momentum of a system of material points. Meshchersky equation. Tsiolkovsky formula	LC, LR, SZ
		1.3	Work and energy. Work of constant and variable force. Power. Potential and non-potential forces. Potential and kinetic energy. Law of conservation of mechanical energy. Sliding friction. Dissipation of mechanical energy. Central absolutely elastic and inelastic impacts.	LC, LR, SZ
		1.4	Rotational movement of the body. Translational and rotational movement of the body. Angular displacement, angular velocity, angular acceleration. Rotational moment. Moment of inertia of the body. Huygens-Steiner theorem. Momentum of a rotating body. The second law of dynamics for the rotational motion of a body. Work and power during rotational motion. Law of conservation of angular momentum. Gyroscopes and their applications.	LC, LR, SZ
		1.5	Gravitational forces. Inertia forces. The law of universal gravitation. Gravitational field. Gravity and body weight. Weightlessness. The work of gravity when moving a body in the Earth's gravitational field. Kepler's laws. First and second escape velocities. Non-inertial reference systems. Centrifugal and Coriolis inertial forces in a rotating system. Movement of bodies near the Earth's surface.	LC, LR, SZ
		1.6	Fundamentals of the special theory of relativity. Postulates of the special theory of relativity. Lorentz transformations. Relativity of lengths and time intervals.	LC, LR, SZ
		1.7	Elastic properties of continuous media. Particle vibrations. Types of elastic deformations: tension, shear, torsion, volumetric expansion and compression. Hooke's law for elastic deformations. Young's modulus. Shear modulus. Poisson's ratio. Simple harmonic oscillation. Energy of an oscillating particle. Pendulums. Free damped oscillations. Forced vibrations. Resonance.	LC, LR, SZ
		1.8	Mechanical waves. Acoustics elements. Running wave. Transverse and longitudinal waves. One-dimensional wave equation. Longitudinal waves in	LC, LR, SZ

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
			a solid. Waves in gases and liquids. Flow of traveling wave energy. Wave interference. Standing waves. Shock waves. Sound. Sound speed. Dependence of the speed of sound on the elastic properties of the medium. Pitch, timbre, intensity and volume of sound. Ultrasound and its application.	
Section 2	Molecular physics	2.1	Kinetic theory of gases. Ideal gas. Equation of state of an ideal gas. Basic equation of the kinetic theory of gases. Root mean square, average and most probable velocities of molecules. Maxwellian velocity distribution of gas molecules. Barometric formula. Boltzmann distribution.	LC, LR, SZ
		2.2	Laws of thermodynamics. Thermodynamic systems. Work when gas volume changes. The first law of thermodynamics. Internal energy of an ideal gas. Heat capacity at constant volume and constant pressure. Equilibrium and nonequilibrium processes. Second law of thermodynamics.	LC, LR, SZ
		2.3	Methods of thermodynamics. The concept of entropy of an ideal gas. Relationship between entropy and the thermodynamic probability of the state of the system. An increase in entropy in an isolated system. Third law of thermodynamics. Adiabatic process. Poisson's equation. Work, heat and change in internal energy during isoprocesses in an ideal gas. The number of degrees of freedom of a molecule. Carnot cycle. Efficiency of the Carnot cycle.	LC, LR, SZ
		2.4	Transference phenomena. Thermal conductivity, Fourier's law, thermal conductivity coefficient. Diffusion, Fick's law, diffusion coefficient. Relationship between thermal conductivity and diffusion of an ideal gas.	LC, LR, SZ
		2.5	Real gases. Lenard-Jones pairwise intermolecular interaction potential. Van der Waals equation. Critical point. Reduced form of the van der Waals equation. Law of corresponding states. Joule-Thomson effect. Inversion point. Liquefaction of gases.	LC, LR, SZ
		2.6	Solids. Crystalline and amorphous bodies. Types of crystal structures: ionic, atomic, metallic and molecular. Types of bonds in a crystal. Heat capacity of solids. Dulong and Petit's law. Point defects in crystals: vacancies, interstitial impurities, substitutional impurities. Edge and screw dislocations.	LC, LR, SZ
		2.7	Liquids. Characteristics of the liquid state. Surface layer of liquid. Surface tension. Pressure of a curved liquid surface. Laplace's formula. Capillary phenomena. Wetting hard surfaces. Surfactants, their properties and applications.	LC, LR, SZ
		2.8	Phase transitions. Thermodynamic phases. Phase equilibrium condition. Phase transitions of the first order. Phase equilibrium line (binodal). State diagram of a one-component substance. Triple point. Critical point. Clapeyron-Clausius equation. Dependence of saturated vapor pressure on	LC, LR, SZ

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
			temperature. Thermodynamic stability of the phase. Spinodal. Metastable phases. Liquid-vapor transition according to the van der Waals equation. Van der Waals isotherms. Explosive boiling.	
Section 3	Electricity and magnetism	3.1	Electrostatic field. Electric, magnetic and electromagnetic field. Charges. Elementary charge. Law of conservation of charge. Coulomb's law. Electrostatic field. Tension and field lines. Potential nature of the electrostatic field. Potential. The relationship between tension and potential. Conductors in an electric field. Electric field induction. Induction vector flux. Ostrogradsky-Gauss theorem. Relationship between surface charge density and field strength near the surface of a charged conductor.	LC, LR, SZ
		3.2	Field of charged conductors and capacitors. Electrical capacity of conductors and capacitors. Field of a charged plate. Field of a parallel-plate capacitor. Electric field energy. Energy density. Field of a spherical capacitor. Field of the solitary sphere. The relationship between the surface charge density and the curvature of the surface of a charged conductor. Field of a cylindrical capacitor.	LC, LR, SZ
		3.3	Dielectrics. Dielectric constant of dielectrics. Electric dipole moment. Polarization of dielectrics. Polarization vector. Electric field strength in a dielectric. Polar and non-polar dielectrics. Dependence of the dielectric constant of a dielectric on temperature. Ferroelectrics and their properties. Direct and reverse piezoelectric effect. Application of piezoelectrics.	LC, LR, SZ
		3.4	Laws of direct current. Current strength and density. Ohm's and Joule-Lenz's laws; differential form of these laws. Electromotive force of the source. Ohm's law for a circuit containing an emf. Kirchhoff's rules for branched electrical circuits.	LC, LR, SZ
		3.5	Electronic properties of metals. Metals, dielectrics, semiconductors. Degenerate electron gas in a metal. Fermi energy. Electrical conductivity of metals. Dependence of the electrical resistance of metals on temperature, impurities and defects in the crystal structure. Superconductivity of metals. High temperature superconductivity.	LC, LR, SZ
		3.6	Contact phenomena in metals. The work function of an electron leaving a metal. Contact potential difference. Thermocouple. Thermoelectromotive force. Temperature measurement with a thermocouple. Peltier effect and its application.	LC, LR, SZ
		3.7	Electric current in a vacuum. Thermionic emission. Vacuum diode. Volt-ampere characteristics of the diode. The role of space charge. Richardson's formula. Vacuum triode. Characteristics and parameters of the triode.	LC, LR, SZ
		3.8	Semiconductors. Semiconductor materials. The band gap of a semiconductor. Intrinsic electrical conductivity of a semiconductor. Conductivity due to impurities. Donor and acceptor semiconductors,	LC, LR, SZ

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
			eg the transition of two semiconductors. Semiconductor diodes.	
		3.9	Electric current in gas. Gas ionization. Non-self-sustaining gas discharge. Electrical conductivity of gas. Types of independent discharges: glow, spark, corona, arc. Plasma and its main parameters.	LC, LR, SZ
		3.10	A magnetic field. A magnetic field. Lorentz force. Induction and magnetic field strength. Biot-Savart-Laplace law. Field of circular and linear currents. Magnetic field of a toroid and solenoid. Vortex nature of the magnetic field. Ampere's law. The force of interaction between long parallel conductors and current. Magnetic moment of a current-carrying circuit. The effect of a magnetic field on a current-carrying circuit. Magnetic flux. Circulation of the magnetic field induction vector.	LC, LR, SZ
		3.11	Electromagnetic induction. Causes of e.m.f. induction and induced current. Faraday's law and Lenz's rule. Induction emf when a conductor moves and a circuit rotates in a uniform magnetic field. Loop inductance. E.m.f. self-induction. Self-induction when closing and opening DC circuits. Magnetic field energy, energy density. Mutual induction of two circuits. Eddy currents. Skin effect.	LC, LR, SZ
		3.12	Magnetic properties of matter. Magnetization of matter. Magnetization vector. Elementary currents of Ampere. Diamagnets and paramagnets. Dependence of magnetization of magnets on magnetic field strength and temperature. Properties of ferromagnets. Curie point. Magnetic hysteresis.	LC, LR, SZ
		3.13	Charged particles and plasma in magnetic and electric fields. Lorentz force. Movement of a charged particle in a magnetic field. Charged particle accelerators. Mass spectroscopy. Cathode-ray tube. Plasma in a magnetic field. Current in plasma. Pinch effect.	LC, LR, SZ
		3.14	Electromagnetic vibrations. Oscillatory circuit. Free oscillations in the circuit. Forced vibrations. Contour quality factor. Active resistance, capacitance and inductance in an alternating current circuit. Alternating electric current. Resonance of currents. Voltage resonance. Impedance. Power at alternating current.	LC, LR, SZ
		3.15	Electromagnetic waves. Electromagnetic waves. Equation of the simplest electromagnetic wave in ordinary and differential forms. The speed of propagation of electromagnetic waves. Electromagnetic wave energy. Umov-Poynting vector.	LC, LR, SZ
		3.16	Maxwell's equations. Bias current. Maxwell's first equation. Vortex electric field. Maxwell's second equation. Maxwell's system of equations in integral and differential form.	LC, LR, SZ
Section 4	Optics, atomic physics, elements of nuclear physics	4.1	Laws of geometric optics: Snell, reflection of light, rectilinear propagation of light, independence of light rays.	LC, LR, SZ

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
		4.2	Characteristics of thin lenses: focal length, optical power. Thin lens formula. Rules for constructing images in a lens.	LC, LR, SZ
		4.3	Photometric quantities and their units: luminous flux, luminous intensity, illumination, brightness, luminosity. Lambert's relation. Spectral sensitivity of the human eye. Magnification of optical instruments: magnifying glass, lens, microscope, telescope.	LC, LR, SZ
		4.4	The concept of an electromagnetic wave. Plane and spherical waves. Monochromatic. Electromagnetic wave scale. Electromagnetic wave equation for spherical and plane waves. The speed of propagation of electromagnetic waves in a medium. The concept of phase and group velocity. Umov-Poynting vector. Volumetric energy density of electromagnetic waves.	LC, LR, SZ
		4.5	Interference. Conditions for observing interference. The concept of coherence. Optical path difference. Conditions for maximum and minimum intensity. Methods for observing interference: Young's method, Fresnel mirror, Fresnel biprism. Interference on plane-parallel plates and plates of variable thickness. Newton's rings. Michelson interferometer. Fabry-Perot standard.	LC, LR, SZ
		4.6	Diffraction of light. Fresnel diffraction. Fraunhofer diffraction. Huygens' principle. Huygens-Fresnel principle. Fresnel zone method. Method of graphical addition of amplitudes. Fresnel diffraction on the simplest obstacles: on a round hole, on a round disk, on the straight edge of a half-plane. Cornu spiral. Fraunhofer diffraction by a slit. Diffraction grating. Rayleigh solvability criterion. X-ray diffraction.	LC, LR, SZ
		4.7	Holography. Method for obtaining and restoring an image.	LC, LR, SZ
		4.8	Dispersion. Bouguer's law. Absorption of waves in liquids and gases. Scattering of light. Rayleigh's law.	LC, LR, SZ
		4.9	Polarization. Types of polarization.	LC, LR, SZ
		4.10	Absolutely black body. Gray body. Wien's law of displacement.	LC, LR, SZ
		4.11	Photo effect. Einstein's equation for the photoelectric effect.	LC, LR, SZ
		4.12	Compton effect. Wave-particle duality. De Broglie waves.	LC, LR, SZ
		4.13	Heisenberg uncertainty principle.	LC, LR, SZ
		4.14	Bohr's postulates. Quantum transitions. Series by Lyman, Balmer, Paschen, Brackett, Pfund.	LC, LR, SZ
		4.15	Spin concept.	LC, LR, SZ
		4.16	Pauli's principle. Fermions and bosons.	LC, LR, SZ
		4.17	Fermi-Dirac and Bose-Einstein statistics.	LC, LR, SZ

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
		4.18	The structure of the atomic nucleus. Mass and binding energy of the atomic nucleus. Mass defect of the atomic nucleus.	LC, LR, SZ
		4.19	Radioactivity. Radioactive decay. Nuclear forces. The mechanism of action of nuclear forces. Nuclear reactions.	LC, LR, SZ
		4.20	The principle of laser operation.	LC, LR, SZ

* - to be filled out only for full-time education: LC – lectures; LR – laboratory work; SZ – practical/seminar classes.

6. MATERIAL AND TECHNICAL SUPPORT OF DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Auditorium equipment	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations.	
Computer class	Computer class for conducting classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with personal computers (10 pcs.), a whiteboard (screen) and technical means for multimedia presentations.	
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations.	
For independent work	An auditorium for independent work by students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to EIOS.	

* - the audience for independent work of students is MANDATORY!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF DISCIPLINE

Main literature:

1. Savelyev Igor Vladimirovich. General physics course: Textbook for colleges: In 5 books.Book 1: Mechanics. - M.: Astrel: AST, 2002, 2003, 2004, 2006.

2. Savelyev Igor Vladimirovich. General physics course: Molecular physics and thermodynamics: In 5 books: Textbook for colleges.Book 2. - M.: Astrel: AST, 2001, 2003, 2002.

3. Savelyev Igor Vladimirovich. General physics course: Molecular physics and thermodynamics: In 5 books: Textbook for colleges.Book 3. - M.: Astrel: AST, 2001, 2003, 2002.

4. Savelyev Igor Vladimirovich. General physics course: Textbook for colleges: In 5 books.Book 4: Waves. Optics. - M.: Astrel: AST, 2002

5. Savelyev Igor Vladimirovich. General physics course: Textbook for colleges: In 5 books. Book 5. Quantum optics. Atomic physics. Solid state physics. Physics of the atomic nucleus and elementary particles. - M.: Astrel: AST, 2002.

6. Irodov Igor Evgenievich. Problems in general physics: Textbook for universities. - 8th ed.; Electronic text data. - M.: BINOM.Knowledge Laboratory, 2010.

Additional literature:

1. Savelyev Igor Vladimirovich. General physics course: Textbook: In 3 volumes. T. 1: Mechanics.Molecular physics. - 2nd ed., revised. - M.: Nauka, 1982.

2. Savelyev Igor Vladimirovich. General physics course: Textbook: In 3 volumes. T. 2: Electricity and magnetism.Waves. Optics. - 2nd ed., revised. - M.: Nauka, 1982.

3. Savelyev Igor Vladimirovich. General physics course: Textbook: In 3 volumes. T. 3: Quantum optics. Atomic physics. Solid state physics. Physics of the atomic nucleus and elementary particles. - 3rd ed., corrected. - M.: Science, 1987

Resources of the information and telecommunications network "Internet":

1. EBS of RUDN University and third-party EBS, to which university students have access based on concluded agreements

- Electronic library system of RUDN University - EBS RUDN Universityhttp://lib.rudn.ru/MegaPro/Web
- EBS "University Library Online"http://www.biblioclub.ru
- EBS Lawhttp://www.biblio-online.ru
- EBS "Student Consultant"www.studentlibrary.ru
- EBS "Trinity Bridge"

2. Databases and search engines

- electronic fund of legal and regulatory technical documentationhttp://docs.cntd.ru/
- Yandex search enginehttps://www.yandex.ru/
- search systemGoogle https://www.google.ru/
- abstract databaseSCOPUS http://www.elsevierscience.ru/products/scopus/

Educational and methodological materials for students' independent work when mastering a discipline/module:*

1. A course of lectures on the discipline "Physics".

* - all educational and methodological materials for students' independent work are posted in accordance with the current procedure on the discipline page in TUIS!

8. ASSESSMENT MATERIALS AND POINT-RATING SYSTEM FOR ASSESSING THE LEVEL OF COMPETENCIES FOR A DISCIPLINE

Evaluation materials and point-rating system* for assessing the level of development of competencies (parts of competencies) based on the results of mastering the discipline"Physics" are presented in the Appendix to this Work Program of the discipline.

* - OM and BRS are formed on the basis of the requirements of the relevant local regulatory act of RUDN University.

DEVELOPER:

Assistant professor		Saltykova Olga Alexandrovna
Position	*Signature*	*Last name I.O.*

HEAD OF BUP:

Head of the department		Razumny Yuri Nikolaevich
Position	*Signature*	*Last name I.O.*

HEAD OF OP VO:

Professor		Razumny Yuri Nikolaevich
Position	*Signature*	*Last name I.O.*