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

Academy of Engineering
(name of the main educational unit (MEU) that developed the educational program of higher education)

WORKING PROGRAM OF THE DISCIPLINE

PHYSICS
(name of discipline/module)

Recommended for the field of study/specialty:

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

The discipline is mastered within the framework of the implementation of the main professional educational program of higher education (EP HE):

DATA SCIENCE AND SPACE SYSTEMS
(name (profile/specialization) of the educational institution of higher education)

2025

1. THE GOAL OF MASTERING THE DISCIPLINE

The discipline "Physics" is included in the bachelor's program "Data Science and Space Systems" in the direction 27.03.04 "Control in Technical Systems" and is studied in semesters 1, 2 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, basic concepts of modern physics.

The purpose 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 the self-development of students, and developing the ability to highlight the main thing when constructing mathematical models.

2. REQUIREMENTS TO 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 developed in students while mastering the discipline (results of mastering the discipline)

Cipher	Competence	Indicators of Competence Achievement (within the framework of this discipline)
GPC-1	Able to analyze the tasks of professional activity based on provisions, laws and methods in the field of natural sciences and mathematics	GPC-1.1 Possesses basic knowledge obtained in the field of mathematical and (or) natural sciences; GPC-1.2 Knows how 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 THE DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL EDUCATIONAL EDUCATION

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

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

Table 3.1. List of components of the educational program of higher education that contribute to the achievement of the planned results of mastering the discipline

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
GPC-1	Able to analyze the tasks of professional activity based on provisions, laws and methods in the field of natural sciences and mathematics		Research work / Scientific research work; Technological Training; Undergraduate Training; Research Work; Space Flight Mechanics; Complex analysis;

* - filled in in accordance with the competency matrix and the SUP EP HE

** - elective disciplines/practices

4. SCOPE OF THE DISCIPLINE AND TYPES OF STUDY WORK

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

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

Type of academic work	**TOTAL,**ac.h.		**Semester(s)**	
			1	**2**
Contact work, academic hours	*105*		*54*	*51*
Lectures (LC)	35		18	17
Laboratory work (LW)	35		18	17
Practical/seminar classes (SC)	35		18	17
Independent work of students, academic hours	*66*		*36*	*30*
Control (exam/test with assessment), academic hours	*45*		*18*	*27*
General complexity of the discipline	**ac.h.**	***216***	*108*	*108*
	credit.ed.	***6***	*3*	*3*

5. CONTENT OF THE DISCIPLINE

Table 5.1. Contents of the discipline (module) by types of academic work

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
Section 1	Mechanics	1.1	Kinematics of a material point. Mechanical motion. Material point. Reference system. Rectilinear and curvilinear, uniform and variable motion. Speed, displacement, path, trajectory, acceleration. Normal and tangential acceleration.	LC, LW, SC
		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 momentum. Newton's third law. A system of material points; the center of mass and momentum of the system. Theorem on the motion of the center of mass. The law of conservation of momentum of a system of material points. Meshchersky's equation. TsioLCovsky's formula	LC, LW, SC
		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 perfectly elastic and inelastic impacts.	LC, LW, SC
		1.4	Rotational motion of a body. Translational and rotational motion of a body. Angular displacement, angular velocity, angular acceleration. Rotational moment. Moment of inertia of a body. Huygens-Steiner theorem. Angular momentum of a rotating body. The second law of dynamics for rotational motion of a body. Work and power in rotational motion. Law of conservation of angular momentum. Gyroscopes and their application.	LC, LW, SC
		1.5	Gravitational forces. Inertial forces. Law of universal gravitation. Gravitational field. Gravity and body weight. Weightlessness. Work of gravity when moving a body in the Earth's gravitational field. Kepler's laws. First and second cosmic velocities. Non-inertial reference systems. Centrifugal and Coriolis inertial forces in a rotating system. Motion of bodies near the Earth's surface.	LC, LW, SC
		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, LW, SC
		1.7	Elastic properties of continuous media. Particle oscillations. Types of elastic deformations: extension, 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 oscillations. Resonance.	LC, LW, SC
		1.8	Mechanical waves. Elements of acoustics. Traveling wave. Transverse and longitudinal waves. One-dimensional wave equation. Longitudinal waves in a solid. Waves in gases and	LC, LW, SC

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
			liquids. Energy flow of a traveling wave. Wave interference. Standing waves. Shock waves. Sound. Speed of sound. Dependence of the speed of sound on the elastic properties of the medium. Pitch, timbre, intensity and loudness 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. Mean square, average and most probable velocities of molecules. Maxwell distribution of gas molecules by velocities. Barometric formula. Boltzmann distribution.	LC, LW, SC
		2.2	Laws of thermodynamics. Thermodynamic systems. Work with changing gas volume. 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, LW, SC
		2.3	Methods of thermodynamics. Concept of entropy of an ideal gas. Relationship of entropy with thermodynamic probability of the system state. Increase of entropy in an isolated system. Third law of thermodynamics. Adiabatic process. Poisson equation. Work, heat and change of internal energy during isoprocesses in an ideal gas. Number of degrees of freedom of a molecule. Carnot cycle. Efficiency of the Carnot cycle.	LC, LW, SC
		2.4	Transfer 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, LW, SC
		2.5	Real gases. Lennard-Jones potential of pairwise intermolecular interaction. 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, LW, SC
		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 laws. Point defects in crystals: vacancies, interstitial impurities, substitutional impurities. Edge and screw dislocations.	LC, LW, SC
		2.7	Liquids. Characteristics of the liquid state. Surface layer of liquid. Surface tension. Pressure of the curved surface of a liquid. Laplace formula. Capillary phenomena. Wetting of solid surfaces. Surface-active substances, their properties and application.	LC, LW, SC
		2.8	Phase transitions. Thermodynamic phases. Phase equilibrium condition. Phase transitions of the first kind. Phase equilibrium line (binodal). State diagram of a single-component substance. Triple point. Critical point. Clausius-Clapeyron equation. Dependence of saturated vapor pressure on temperature. Thermodynamic stability of the phase. Spinodal. Metastable phases. Liquid-vapor	LC, LW, SC

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
			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. Field strength and lines of force. Potential nature of electrostatic field. Potential. Relationship between strength 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, LW, SC
		3.2	Field of charged conductors and capacitors. Electric capacity of conductors and capacitors. Field of a charged plate. Field of a flat capacitor. Electric field energy. Energy density. Field of a spherical capacitor. Field of a solitary sphere. Relationship between surface charge density and curvature of the surface of a charged conductor. Field of a cylindrical capacitor.	LC, LW, SC
		3.3	Dielectrics. Dielectric constant of dielectrics. Electric moment of dipole. Polarization of dielectrics. Polarization vector. Electric field strength in a dielectric. Polar and non-polar dielectrics. Dependence of dielectric permittivity on temperature. Ferroelectrics and their properties. Direct and inverse piezoelectric effect. Application of piezoelectrics.	LC, LW, SC
		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 a source. Ohm's law for a circuit containing EMF. Kirchhoff's rules for branched electric circuits.	LC, LW, SC
		3.5	Electronic properties of metals. Metals, dielectrics, semiconductors. Degenerate electron gas in a metal. Fermi energy. Electrical conductivity of metals. Dependence of electrical resistance of metals on temperature, impurities and defects of the crystal structure. Superconductivity of metals. High-temperature superconductivity.	LC, LW, SC
		3.6	Contact phenomena in metals. Electron work function of a metal. Contact potential difference. Thermocouple. Thermoelectromotive force. Temperature measurement with a thermocouple. Peltier effect and its application.	LC, LW, SC
		3.7	Electric current in vacuum. Thermionic emission. Vacuum diode. Volt-ampere characteristic of the diode. The role of space charge. Richardson formula. Vacuum triode. Characteristics and parameters of the triode.	LC, LW, SC
		3.8	Semiconductors. Semiconductor materials. Band gap of a semiconductor. Intrinsic conductivity of a semiconductor. Conductivity due to impurities. Donor and acceptor semiconductors, n-p junction of two semiconductors. Semiconductor diodes.	LC, LW, SC
		3.9	Electric current in gas. Gas ionization. Non-self-sustaining gas discharge. Electrical conductivity of gas. Types of self-sustaining discharges: glow,	LC, LW, SC

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
			spark, corona, arc. Plasma and its main parameters.	
		3.10	Magnetic field. Magnetic field. Lorentz force. Magnetic induction and field strength. Biot-Savart-Laplace law. Field of circular and rectilinear currents. Magnetic field of a toroid and solenoid. Vortex nature of a magnetic field. Ampere's law. Force of interaction of long parallel conductors with current. Magnetic moment of a circuit with current. Action of a magnetic field on a circuit with current. Magnetic flux. Circulation of the magnetic field induction vector.	LC, LW, SC
		3.11	Electromagnetic induction. Causes of induction emf and induction current. Faraday's law and Lenz's rule. Induction emf during conductor movement and circuit rotation in a uniform magnetic field. Circuit inductance. Self-induction emf. Self-induction during closing and opening of DC circuits. Magnetic field energy, energy density. Mutual induction of two circuits. Eddy currents. Skin effect.	LC, LW, SC
		3.12	Magnetic properties of matter. Magnetization of matter. Magnetization vector. Elementary Ampere currents. Diamagnets and paramagnets. Dependence of magnetization of magnetic materials on magnetic field strength and temperature. Properties of ferromagnets. Curie point. Magnetic hysteresis.	LC, LW, SC
		3.13	Charged particles and plasma in magnetic and electric fields. Lorentz force. Motion of a charged particle in a magnetic field. Accelerators of charged particles. Mass spectroscopy. Cathode-ray tube. Plasma in a magnetic field. Current in plasma. Pinch effect.	LC, LW, SC
		3.14	Electromagnetic oscillations. Oscillatory circuit. Free oscillations in the circuit. Forced oscillations. Circuit quality factor. Active resistance, capacitance and inductance in an alternating current circuit. Alternating electric current. Current resonance. Voltage resonance. Impedance. Power at alternating current.	LC, LW, SC
		3.15	Electromagnetic waves. Electromagnetic waves. The equation of the simplest electromagnetic wave in ordinary and differential forms. The speed of propagation of electromagnetic waves. The energy of an electromagnetic wave. The Umov-Poynting vector.	LC, LW, SC
		3.16	Maxwell's equations. Displacement current. Maxwell's first equation. Vortex electric field. Maxwell's second equation. Maxwell's system of equations in integral and differential form.	LC, LW, SC
Section 4	Optics, atomic physics, elements of nuclear physics	4.1	Laws of geometric optics: Snell's, reflection of light, rectilinear propagation of light, independence of light rays.	LC, LW, SC
		4.2	Characteristics of thin lenses: focal length, optical power. Formula of thin lens. Rules for constructing images in a lens.	LC, LW, SC
		4.3	Photometric quantities and their units: luminous flux, luminous intensity, illumination, brightness,	LC, LW, SC

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
			luminosity. Lambert ratio. Spectral sensitivity of the human eye. Magnification of optical instruments: magnifying glass, lens, microscope, telescope.	
		4.4	The concept of an electromagnetic wave. Plane and spherical waves. Monochromaticity. The scale of electromagnetic waves. The equation of an electromagnetic wave for spherical and plane waves. The speed of propagation of electromagnetic waves in a medium. The concept of phase and group velocity. The Umov-Poynting vector. The volumetric energy density of electromagnetic waves.	LC, LW, SC
		4.5	Interference. Conditions for observing interference. The concept of coherence. Optical path difference. Conditions of 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 etalon.	LC, LW, SC
		4.6	Light diffraction. Fresnel diffraction. Fraunhofer diffraction. Huygens principle. Huygens-Fresnel principle. Fresnel zone method. Method of graphic addition of amplitudes. Fresnel diffraction by the simplest obstacles: by a round hole, by a round disk, by a straight edge of a half-plane. Cornu spiral. Fraunhofer diffraction by a slit. Diffraction grating. Rayleigh resolvability criterion. X-ray diffraction.	LC, LW, SC
		4.7	Holography. Method of obtaining and restoring an image.	LC, LW, SC
		4.8	Dispersion. Bouguer's law. Wave absorption in liquids and gases. Light scattering. Rayleigh's law.	LC, LW, SC
		4.9	Polarization. Types of polarization.	LC, LW, SC
		4.10	Absolutely black body. Gray body. Wien's displacement law.	LC, LW, SC
		4.11	Photoelectric effect. Einstein's equation for the photoelectric effect.	LC, LW, SC
		4.12	Compton effect. Wave-corpuscle duality. De Broglie waves.	LC, LW, SC
		4.13	Heisenberg uncertainty principle.	LC, LW, SC
		4.14	Bohr's postulates. Quantum transitions. Lyman, Balmer, Paschen, Brackett, Pfund series.	LC, LW, SC
		4.15	The concept of spin.	LC, LW, SC
		4.16	Pauli's exclusion principle. Fermions and bosons.	LC, LW, SC
		4.17	Fermi-Dirac and Bose-Einstein statistics.	LC, LW, SC
		4.18	Structure of the atomic nucleus. Mass and binding energy of the atomic nucleus. Mass defect of the atomic nucleus.	LC, LW, SC
		4.19	Radioactivity. Radioactive decay. Nuclear forces. Mechanism of action of nuclear forces. Nuclear reactions.	LC, LW, SC

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
		4.20	The principle of laser operation.	LC, LW, SC

* - filled in only for FULL-TIME education: LC – lectures; LW – laboratory work; SC – practical/seminar classes.

6. LOGISTIC AND TECHNICAL SUPPORT OF DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Equipping the auditorium	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; a board (screen) and technical means for multimedia presentations.	
Computer class	A computer room for conducting classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with personal computers (14 in total), a board (screen) and technical means for multimedia presentations.	
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with a set of specialized furniture and technical means for multimedia presentations.	
For independent work	A classroom for independent work of students (can be used for conducting seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System.	

* - the audience for independent work of students MUST be indicated!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. Savelyev Igor Vladimirovich. General Physics Course: Textbook for Higher Technical Universities: In 5 books.Book 1: Mechanics. - M.: Astrel: AST, 2002, 2003, 2004, 2006.

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

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

4. Savelyev Igor Vladimirovich. General Physics Course: Textbook for Higher Technical Universities: In 5 books.Book 4: Waves. Optics. - M.: Astrel: AST, 2002

5. Saveliev Igor Vladimirovich. General Physics Course: Textbook for Technical 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.Laboratory of knowledge, 2010.

Further reading:

1. Saveliev Igor Vladimirovich. General Physics Course: Textbook: In 3 volumes. Volume 1: Mechanics.Molecular Physics. - 2nd ed., revised. - M.: Nauka, 1982.

2. Savelyev Igor Vladimirovich. General Physics Course: Textbook: In 3 volumes. Volume 2: Electricity and Magnetism.Waves. Optics. - 2nd ed., revised. - M.: Nauka, 1982.

3. Saveliev Igor Vladimirovich. Course of General Physics: Textbook: In 3 volumes. Volume 3: Quantum Optics. Atomic Physics. Solid State Physics. Physics of the Atomic Nucleus and Elementary Particles. - 3rd ed., corrected. - Moscow: Nauka, 1987

Resources of the information and telecommunications network "Internet":

1. RUDN University EBS and third-party EBSs to which university students have access on the basis of concluded agreements

- Electronic library system of RUDN - ELS RUDNhttp://lib.rudn.ru/MegaPro/Web
- Electronic library system "University library online"http://www.biblioclub.ru
- EBS Yuraithttp://www.biblio-online.ru
- Electronic Library System "Student Consultant" www.studentlibrary.ru
- Electronic library system "Troitsky Bridge"

2. Databases and search engines

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

Educational and methodological materials for independent work of students in mastering a discipline/module:*

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

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

DEVELOPER:

Professor		Kupreev Sergey Alekseevich
Position, Department	*Signature*	*Surname I.O.*

HEAD OF THE DEPARTMENT:

Head of Department		Razumny Yuri Nikolaevich
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