REPUBLIC OF UZBEKISTAN

MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATIONS

FERGANA STATE TECHNICAL UNIVERSITY

Physics

MODULE HANDBOOK

Knowledge area:	700000	Engineering, Power Engineering and Construction
Educational field:	730 000	Architecture and Construction
Education program:	60730300	Civil Engineering

Fergana 2025

Module title	***Physics***
Code (if available)	*Phys1M16, Phys2M26, Phys3M36*
Semester(s) of module teaching	*1,2,3*
Responsible for the module	*Akhmadaliev Bozorboy Jaboralievich Akhmadaliev, Department of Physics, Ph.D.* *Nurmatov Ozodbek Ravshanboyevich, Assistant Professor.*
Language of instruction	*Uzbek, Russian*
Connection to the curriculum	*Compulsory*
Teaching methods	*lectures, practical classes, laboratory works, independent study*
Study load (including classroom and independent study hours)	*Total: 540 hours* *Auditorium hours: 216 hours* *lectures - 80 hours, practical classes - 98 hours, laboratory work - 38 hours, independent study - 324 hours*
Credit units	***18***
Required and recommended prior knowledge for studying the module	*Mathematics*
Module objectives/expected learning outcomes	The module aims to teach students the basic units of physics: mechanics, molecular physics, thermodynamics, electrostatics, electric current, magnetic field, optics and modern physics. Students will develop skills in applying this knowledge to building structures and engineering systems, modelling, calculating and practical application of physical phenomena such as energy consumption and electromagnetic effects. Requirements for the subject: Mechanics: Study the laws of statics and dynamics, be able to analyse forces and moments in structures, calculate equilibrium and deformations. Molecular physics and thermodynamics: Understand the molecular structure of matter, heat capacity, expansion, pressure and energy exchange, perform calculations for thermal conductivity and energy efficiency. Electrostatics and electric current: Analyse electrical circuits, calculate voltage, resistance and power, know electrical safety requirements. Magnetic field and electromagnetic induction: Measure magnetic fields and understand the use of electromagnetic forces in engineering systems. Optics: Understand the phenomena of lenses, refraction, polarisation and dispersion, and take into account the lighting systems of buildings. Atomic, nuclear and modern physics: Know the structure of atoms and nuclei, the laws of radioactive decay, quantum phenomena, and apply semiconductor and laser technologies. Practical aspect: Apply the laws of physics in construction, perform physical modelling, analyse experimental results and make decisions based on technical calculations.
Content	***Module 1: Mechanics (topics 1–12)*** *Introduction to physics. Physical quantities and the SI system*

	(subject, methods and units of measurement) *Mechanical motion. Uniform and non-uniform rectilinear motion (basic concepts of velocity, acceleration and types of motion)* *Curvilinear motion. Circular motion and angular velocity (study of angular quantities and centripetal acceleration)* *Addition of motions and the principle of relativity (analysis of motion in different reference frames)* *Newton's laws. The concept of force (the nature of force and Newton's laws)* *Forces in nature: gravity, elasticity, friction (types of forces and their effect on bodies)* *Momentum and the law of conservation of momentum (momentum and its conservation in collisions)* *Work, power and energy. The law of conservation of mechanical energy (concepts and transformations of energy)* *Central forces. The motion of artificial satellites (orbital motion and gravitational forces)* *The dynamics of rotational motion. Moments and moment of inertia (rotation of bodies and inertia)* *Elements of statics and conditions of equilibrium (equilibrium and analysis of acting forces)* *Introduction to the special theory of relativity. Lorentz transformations (behaviour of bodies at high speeds)* ***Module 2: Molecular physics and thermodynamics (topics 13–20)*** *Molecular structure of matter. Fundamentals of molecular kinetic theory (motion of particles and their influence on the properties of matter)* *Basic equations of gases and the ideal gas model (mathematical expression and analysis)* *Pressure, temperature and internal energy of gases (interrelation of thermodynamic parameters)* *Heat quantity and heat capacity. Phase transitions (energy for changing the state of matter)* *The first law of thermodynamics. Internal energy and work (energy conservation and work in systems)* *The second law of thermodynamics. The concept of entropy (unidirectional heat flow and increase in disorder)* *Thermodynamic cycles. Efficiency of heat engines (devices based on the conversion of thermal and mechanical energy)* *Real gases and the Van der Waals equation (difference between the behaviour of real gases and ideal models)* ***Module 3: Electrostatics and electric current (topics 21–27)*** *Charge and Coulomb's law. Electric field strength (interaction of charged bodies and electric fields)* *Electric potential, potential energy and work (energy states and motion in an electric field)* *Capacitors and dielectrics. Capacitance (devices for storing charge and their properties)* *Electric circuits and Ohm's law. Current and voltage (the basic law of electric current and circuit elements)* *Work of electric current. Joule–Lenz's law (heat generation and energy consumption in circuits)* *Energy distribution in electrical circuits (energy distribution by voltage*

	and current) *Interaction of current with a magnetic field (effect of a magnetic field on conductors with current, Lorentz force)* *Module 4: Magnetic fields and electromagnetic induction (topics 28–32)* *Magnetic induction and current-carrying conductors (magnetic effects created by current)* *Lorentz force and trajectories of charged particles (motion in magnetic fields)* *Electromagnetic induction. Faraday's and Lenz's laws (the emergence of current when the magnetic field changes)* *Mutual and self-induction (the mechanism of current emergence in one or more coils)* *Alternating current. The phenomenon of resonance and the LC circuit (alternating current and resonance conditions in circuits)* ***Module 5: Optics (topics 33–36)*** *Propagation of light and laws of geometric optics (straight-line propagation, refraction and reflection)* *Reflection, refraction and lenses (change in the direction of light and optical instruments)* *Interference and diffraction in wave phenomena (wave properties of light and related effects)* *Polarisation and dispersion of light. Spectroscopy (spatial properties and spectral composition of light)* ***Module 6: Atomic, nuclear and modern physics (topics 37–40)*** *Quantum properties of light. Photoelectric effect and Compton effect (experiments confirming the corpuscular nature of light)* *Models of the atom. The hydrogen atom and Bohr's postulates (the structure of the atom through historical models)* *Fundamentals of nuclear physics. Radioactive decay and nuclear reactions (the structure of the nucleus and its changes)* *Contemporary trends in physics: semiconductors, lasers, fundamentals of quantum theory (contemporary approa*ches in electronics and optics)
Content	*Module 1: Structural Mechanics and Static Analysis* *Solving problems involving rectilinear motion (the effect of gravity) (Considering the impact of gravitational force when analyzing motion, such as in vertical or horizontal movements)* *Determining the effect of load on cantilever beams (Studying how loads affect cantilever beams and analyzing the resulting force distributions)* *Graphical analysis of support reactions (Applying graphical methods to evaluate support reactions and equilibrium conditions in structures)* *Determining equilibrium under the action of moments and forces (Analyzing the equilibrium state of structures by accounting for applied moments and forces)* *Calculating deformations (tension, compression) in structures (Determining tension and compression deformations based on the elastic properties of construction materials)* *Analysis of real structures in solid statics*

	(Evaluating the static properties of solid building structures in practical scenarios) *Analysis of the action of several forces at one point (Calculating the resultant effect of multiple forces acting at a single point)* *Load distribution in load-bearing columns (vertical load of a building) (Correctly distributing and calculating vertical loads applied to building columns)* *Assessment of the bending resistance of steel and reinforced concrete structures (Analyzing the resistance of steel and reinforced concrete structures to bending and assessing their stability)* *Determination of stress distribution in longitudinal and transverse sections (Calculating the distribution of stresses within structural sections subjected to loads)*
	Module 2: Physics of Building Materials *Density and mass of building materials (Determining the density and mass of construction materials and examining their physical properties)* *Mechanical properties of concrete, brick, and wood (Analyzing the responses of concrete, brick, and wood to mechanical loading)* *Calculation of thermal conductivity coefficients (comparison of materials) (Comparing the thermal conductivity coefficients of various building materials to assess their effectiveness)* *Determination of water absorption of building materials (Evaluating the interaction of materials with water and their water resistance)* *Analysis of deformations associated with temperature changes (Assessing material deformations resulting from temperature fluctuations)* *Analysis of construction plastics and insulation materials (Studying the physical and mechanical properties of plastics and insulating materials used in construction)* *Compressive strength test (using a sample) (Determining the compressive strength of construction materials through laboratory testing)* *Module 3: Thermal and Hydraulic Calculations for Structures* *Calculation of heat loss through the exterior walls of a building (Computing heat loss through exterior walls and investigating methods to minimize it)* *Analysis of the thermal efficiency of the roof (Evaluating heat loss through roofing systems and assessing overall energy efficiency)* *Calculation of heat costs for internal heating (Determining the quantity of heat required for a building's internal heating system)* *Determination of the flow rate in pipes used in construction (Calculating the flow velocity in construction pipes to enhance system performance)* *Determination of hydrostatic pressure and calculation of water balance*

	(Assessing hydrostatic pressure and analyzing water balance in water supply systems) *Determination of flow regime in the external sewerage network (Calculating flow regimes and velocities in external sewer networks)* *Calculating pressure in the drainage system at a construction site (Determining the pressure and evaluating the efficiency of drainage systems on construction sites)* ***Module 4: Electrical, Lighting, and Energy Systems*** *Calculation of lighting power in building structures (Determining the required power for the design and implementation of effective lighting systems)* *Determination of voltage losses in electrical networks (Analyzing voltage drops and energy losses within electrical networks and proposing strategies for reduction)* *Calculation of resistance and power when selecting electrical conductors* *(Calculating resistance and power to ensure the proper selection of electrical conductors)* *Assessment of energy efficiency of buildings (by coefficient) (Calculating and optimizing the energy efficiency of buildings using relevant coefficients)* *Calculation of electricity consumption for electric floor heating systems* *(Determining the electricity consumption of floor heating systems)* *Calculation of electrical safety conditions at the construction site (Evaluating electrical and fire safety conditions at construction sites)* *Module 5: Calculation of building and structure elements (31–35)* *Calculation of the stability of walls, columns and beams under load* *(Assessment of the stability of walls, columns and beams under load.)* *Analysis of forces causing cracks in concrete slabs* *(Calculation and analysis of forces capable of causing cracks in concrete slabs.)* *Determination of the influence of tension in reinforced concrete structures* *(Analysis of tensile and compressive forces in reinforced concrete structures.)* *Calculation of stresses and strains in roofing and frame systems* *(Analysis and calculation of strains and stresses in roofing and frame systems.)* *Calculation of the strength of steel structures* *(Analysis of the strength of steel structures and assessment of their durability.)* *Module 6: Modern physical analysis in civil engineering (36–40)* *Graphical representation of load effects using simulation programs* *(Visualisation of loads on building systems using simulation programs.)* *Analysis of the probability of resonance in building structures* *(Determination of the probability of resonance under the influence of vibrations and external forces and measures to prevent it.)* *Modelling of stress distribution for earthquake-resistant structures* *(Simulation of stress distribution in buildings during earthquakes and their balancing.)* *Deformation of structures under wind pressure (high-rise buildings)* *(Analysis of deformations of tall structures under the influence of*

	wind pressure and their impact on the structure.) *Visual observation of heat loss using thermographic devices* **(**Determination of heat loss in buildings using thermography, analysis of insulation condition and energy efficiency.)
Content	*1. Determining the acceleration of free fall using a mathematical pendulum* *(Useful for modelling the acceleration of bodies moving on the Earth's surface)* *2. Observing energy conversion using Maxwell's pendulum* *(Studying the conversion of various types of energy and the stability of the system)* *3. Determining the surface tension coefficient of a liquid using the drop method* *(Studying the effect of surface forces when working with natural waters)* *4. Determining the volume expansion coefficient of liquids* *(Used to assess changes related to the temperature of groundwater)* *5. Determination of the adiabatic index CP/CV for air using the Richards method* *(Physical modelling of changes in atmospheric pressure and temperature)* *6. Determination of the internal friction coefficient of a liquid using the Stokes method* *(Key parameter for gravitational measurements and movement in soil)* *7. Determination of the modulus of elasticity of steel* *(Assessment of the physical properties of support materials for geodetic instruments in construction)* *8. Measurement of the temperature dependence of the coefficient of linear expansion of solids* *(Experimental study of changes in the length of materials with temperature changes, assessment of the stability of materials in construction and geodesy)* *9. Determination of inductance – measurement of the magnetic field of a coil* *(Preparation for working with compasses and electromagnetic measuring instruments)* *10. Determination of the resistance of a galvanometer by the shunt method* *(Used when working with measuring instruments for electrical signals)* *11. Obtaining the volt-ampere characteristics of a vacuum diode* *(Studying the basics of electronics and the behaviour of current in electronic devices)* *12. Measuring electrical resistance using a Wheatstone bridge* *(Checking the accuracy of electrical circuits when working with geodetic sensors)* *13. Studying charge and electric field – experiments with an electroscope* *(Introduction to the assessment of the Earth's electrical potentials)* *14. Studying the phenomenon of light diffraction* *(Assessing the accuracy of laser measuring instruments in geodesy)* *15. Studying the phenomenon of polarisation and Malus' law* *(Understanding the influence of light direction in remote sensing systems)* *16. Determining the focal length of collecting lenses*

	(Understanding the optical properties of photogrammetric and optical measuring instruments) *17. Studying spherical aberration (optical errors of lenses)* *(Assessing the accuracy of images from surveying instruments and cameras)* *18. Determining the wavelengths of the Ha, Hb, and Hg lines of the Balmer series for hydrogen* *(Measuring the optical emission lines of the hydrogen atom using spectral analysis and understanding quantum transitions between the energy levels of the atom)* *19. Visualisation of particle tracks using a Wilson camera* *(Understanding radioactivity, ionisation and the trajectories of nuclear particles by observing the movement of charged particles in a simulated environment)*
Forms of assessment	*Oral questioning, presentations, written assignments, practical assignments, laboratory work and final exams.*
Requirements for study and assessment	*To successfully complete the course, students must attend classes and achieve the minimum required score in the current, interim and final assessments.*
Bibliography	*The following sources are used in the course:* *Samuel J. Ling, Jeff Sanny, William Moebs, University Physics, Volumes 1, 2, 3, 2021, Rice University, original edition 2020* *Sultanov N.A. 'Physics Course', Fergana, Classic Publishing House, 2021* *Abdurakhmanov K.P., Khamidov V.S., Akhmedova N.A. Physics. Textbook. Tashkent, 2018* *Bodunov E.N., Nikitchenko V.I., Petukhov A.M. Basic Course in Physics. Textbook. Saint Petersburg, 2020* *Paul Peter Urone, Roger Hinrichs, Physics, 2020, Texas Education Agency (TEA), https://openstax.org (electronic version)* *Gaibov A.G. Physics. Study guide. Tashkent, 2019* *Sultanov N.A., Rakhimov E.T. Collection of Problems for Independent Solution in Physics. Fergana, Classic Publishing House, 2021* *Polvonov B.Z. Solving Problems in General Physics. Textbook. Fergana, Classic Publishing House, 2021*
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