National Technical University of Ukraine
«IGOR SIKORSKY KYIV
POLYTECHNIC INSTITUTE»

Department of General Physics and Modelling of Physical Processes

PHYSICS. PART 2. ELECTROSTATICS, ELECTROMAGNETISM, ATOMIC PHYSICS

Working Program of the Academic Discipline (Syllabus)

Course Details

Level of higher education	*First (Bachelor's)*
Branch of knowledge	G Engineering, Manufacturing and Construction
Specialty	G7 Automation, Computer-Integrated Technologies and Robotics
Educational program	"Computer-Integrated Technologies and Robotics"
Course status	Mandatory (normative) (professional training cycle)
Form of study	Full-time (day)
Year of study, semester	1st year, spring semester
Course workload	150 hours (5 ECTS credits): lectures – 30, practical classes – 16, laboratory classes – 14, self-study – 90.
Semester control / control measures	Exam, modular control work
Class schedule	Published on the university website http://rozklad.kpi.ua
Language of instruction	Ukrainian
Information about the course leader / teachers	Lectures: Professor Oksana Gorobets, gorobets.oksana@gmail.com, Senior Lecturer Olha Kerita, o.kerita@kpi.ua Practical classes: Senior Lecturer Olha Kerita, o.kerita@kpi.ua, Assistant, PhD (Physics and Mathematics) Serhii Krasnovyd Laboratory classes: Assistant, PhD (Physics and Mathematics) Serhii Krasnovyd, sergkrasnovyd88@gmail.com, Assistant Nelia Ibrahimova, nelyaibrahimova18@gmail.com, Senior Lecturer Olha Kerita, o.kerita@kpi.ua
Course placement	Link to the distance learning resource: physics.zfftt.kpi.ua

Course Program

1. Course description, its aim, subject of study and learning outcomes

The educational component "Physics" is the fundamental basis for studying a number of disciplines of professional and practical training of engineers in various fields. In the course "Physics", students will gain a thorough understanding of the laws of nature that underlie engineering decisions in solving production tasks.

Physics is one of the main natural science disciplines that study the laws of inanimate nature. Natural sciences today can be understood as those branches of knowledge in which an experiment can be carried out to confirm the assumptions and models put forward by theory. The evolution of the natural sciences has made it possible to significantly expand their research methodology compared with philosophy, of which they were once a part, and to transform them from contemplative into experimental sciences.

In the classical physics course, students study the laws of nature that form the basis of the vast majority of engineering and technical disciplines, which are now independent fields of research and practice.

The aim of the course "Physics" is to provide future specialists with solid knowledge of the laws of nature and the ability to use this knowledge in the further study of specialized disciplines and in their future professional activity.

The subject of the course "Physics" is the basic concepts and laws of inanimate nature.

After completing the course "Physics", the student should *know and be able* to use knowledge of the laws of inanimate nature at the level necessary to achieve other learning outcomes of the educational program, in particular those underlying the professional disciplines.

The student should *be able* to: combine theory and practice to solve practical tasks; apply the principles of systems analysis and of cause-and-effect relationships between significant factors and the scientific and technical decisions made when solving complex professional problems; find the necessary information in the literature, consult and use scientific databases and other relevant sources of information for detailed study and research of engineering issues according to their specialization.

To master the course successfully, the student should have a set of bachelor-level *competences*, in particular: the ability to apply knowledge and understanding of the scientific facts, concepts, theories, principles and methods needed to support an engineering specialization; the ability for abstract thinking, analysis and synthesis; the ability to make informed decisions; the ability to work individually; the ability to work in a team; the ability to use technical literature and other sources of information effectively; the ability to apply knowledge and understanding of the scientific facts, concepts, theories, principles and methods needed for successful work in their professional field.

In particular, the aim of the educational component is to develop the following competences in students:

General competences

GC01. Ability to apply professional knowledge and skills in practical situations.

GC05. Ability to search for, process and analyse information from various sources.

GC08. Ability to learn and master modern knowledge.

Programme learning outcomes

PLO 11. To know and understand modern theoretical and experimental research methods, with assessment of the accuracy of the results obtained.

PLO 18. To be able to apply the knowledge gained in studying fundamental sciences when solving professional tasks.

The syllabus of the course "Physics" is based on the principle of constructive alignment, which makes it possible to anticipate the learning tasks and activities students need to achieve the expected learning outcomes and then to design the learning experience so as to maximise students' opportunities to achieve the desired results.

The syllabus is structured so that each subsequent task requires students to apply the skills and knowledge acquired in the previous one. The final stage is the exam, for which students use the theoretical knowledge and apply the practical skills acquired during all types of tasks (practical and laboratory classes) and through active participation in lectures (completing current tasks and activities). Particular attention is paid to the principle of encouraging active learning, according to which students work on practical thematic tasks that will allow them to solve real problems and tasks in the future.

Learning in practical and laboratory classes is based on a student-centred approach and a strategy of teacher–student interaction aimed at helping students master the material and develop practical skills.

Practical and laboratory classes use:

– active and collaborative learning strategies;

– personality-oriented developmental technologies based on active forms and methods of learning (team-based learning, think-pair-share, brainstorming, discussion, express conference, educational debates, etc.);

– problem-based learning.

For a better understanding of the course structure and mastering of the material, the following communication services are used remotely: "Electronic Campus", Zoom, Telegram, the "Sikorsky"

distance learning platform (Sikorsky Distance), the Moodle web environment at http://physics.zfftt.kpi.ua and e-mail, which help to:

– simplify the placement and exchange of learning materials;

– provide feedback to students on the course content and learning tasks;

– assess students' learning tasks;

– keep records of students' progress on the course plan, the schedule of learning tasks and student assessment.

In full-time study and for interaction with students, modern information, communication and network technologies are used to solve learning tasks, as well as equipment (a projector and electronic presentations for lectures).

The practical skills and theoretical knowledge acquired in the course "Physics" can be used later in the study of specialized disciplines.

2. Prerequisites and postrequisites of the course (place in the structural and logical scheme of training under the relevant educational program)

The course "Physics" is based on the knowledge of physics and mathematics acquired in general secondary education. The educational component involves the use of skills in the theory and technique of experiment and mathematical skills acquired in parallel study of mathematical disciplines. An essential element of the course is mastering the concepts and mathematical tools of mathematical analysis, analytic geometry, linear algebra and vector analysis. Some topics require the ability to solve simple differential equations.

The acquired knowledge and skills will be applied later in the study of both general technical and specialized disciplines. According to the structural and logical scheme, the postrequisites of the course are EC 9 "Electrical Devices of Information and Measurement Systems" and EC 10 "Theory of Electrical Signals and Circuits".

3. Course content

The course "Physics" consists of two content modules. In the second semester, the module "Physics. Part 2. Electrostatics, Electromagnetism, Atomic Physics" is studied.

Content modules and topics	***Number of hours***				
	Total	***including***			
		Lectures	***Practical***	***Laboratory***	***Self-study***
Section 3. Electromagnetism					
Topic 3.1. Introduction to electromagnetism	2	1			1
Topic 3.2. Fundamentals of electrostatics	16	4	2	2	8
Topic 3.3. Vector fields	6	2	1		3
Topic 3.4. Gauss's law	12	2	2	2	6
Topic 3.5. Electric dipole	2	1			1
Topic 3.6. Dielectrics in an electric field	12	4	2		6
Topic 3.7. Conductors in an electric field	10	2	1	2	5
Topic 3.8. Electric capacitance	8	1	1	2	4
Topic 3.9. Laws of direct current	10	2	1	2	5
Topic 3.10. Fundamentals of magnetostatics	16	4	2	2	8
Topic 3.11. Magnetic field in matter	16	4	2	2	8
Topic 3.12. Electromagnetic induction	16	4	2	2	8
Topic 3.13. Maxwell's equations	2	1			1
Topic 3.14. Electromagnetic waves	10	2	1	2	5
Topic 3.15. Energy and momentum of the electromagnetic field	6	2	1		3

Total for Section 3	144	36	18	18	72
Modular control work	6				6
Total hours	150	36	18	18	78

4. Educational materials and resources

RECOMMENDED LITERATURE

1. Kucheruk I. M., Horbachuk I. T., Lutsyk P. P. General Course of Physics. Vol. 1. – Kyiv: Tekhnika, 1999. (STL) [in Ukrainian]
2. Kucheruk I. M., Horbachuk I. T., Lutsyk P. P. General Course of Physics. Vol. 2. – Kyiv: Tekhnika, 2001. (STL) [in Ukrainian]
3. Kucheruk I. M., Horbachuk I. T., Lutsyk P. P. General Course of Physics. Vol. 3. – Kyiv: Tekhnika, 1999. (STL) [in Ukrainian]
4. Physics. Internet resource at URL: http://physics.zfftt.kpi.ua [in Ukrainian]
5. Laboratory Works in Physics. Internet resource at URL: http://physics.zfftt.kpi.ua/mod/page/view.php?id=540 [in Ukrainian]
6. General Course of Physics: Collection of Problems / I. P. Harkusha, I. T. Horbachuk, V. P. Kurinnyi et al. – Kyiv: Tekhnika, 2004. – 560 p. [in Ukrainian]

Educational Content

5. Methods of mastering the course (educational component)

LECTURES

No.	*Lecture topic and main issues (teaching materials, references and self-study assignments)*
1	Introduction to electromagnetism. Properties of the electric force. The field concept. Qualitative consideration of the relationship between electric and magnetic fields.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
2	Fundamentals of electrostatics. Coulomb's law. The electric field of point charges. The superposition principle. The electric field of charges distributed in space.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
3	Fundamentals of electrostatics. Work done in moving a charge in an electric field. Potential energy of a charge in an electric field. Electrostatic potential. Relationship between potential and electric field strength.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
4	Vector fields. Differential and integral calculus of vector fields. The vector operator "nabla". Gradient, divergence and curl. Properties of the flux and circulation of vector fields. The Ostrogradsky–Gauss theorem and Stokes' theorem.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
5	Gauss's law. Flux of the field E. Gauss's law in integral form and its relation to Maxwell's equation. Examples of calculating the electric field using Gauss's law for spherical, cylindrical and planar symmetry of charge distribution.

Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
6	Electric dipole. Potential and electric field of a dipole. The dipole approximation for any charge distribution. Dielectrics in an electric field. Types of polarization of dielectrics. Polarization vector. Surface and volume bound charges. The case of non-uniform polarization.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
7	Dielectrics in an electric field. Electrostatic equations for dielectrics. Electric displacement vector. Boundary conditions at the interface of two dielectrics. Electronic polarization of dielectrics. Orientational polarization of dielectrics. Curie's law.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
8	Conductors in an electric field. The field near the surface of a conductor. Dependence on surface curvature. The method of images. Electrostatic energy of charges. Energy of a capacitor. Energy density of the electrostatic field. Electric capacitance. Capacitors, parallel plates.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
9	Laws of direct current. Electric current and current density. Charge conservation, the continuity equation. Ohm's laws. The Joule–Lenz law. Main principles of the classical theory of electrical conductivity of metals and its experimental confirmation. The Wiedemann–Franz law. Limitations of the classical theory.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
10	Fundamentals of magnetostatics. Properties of the magnetic force. Magnetic induction vector. The magnetic force on a current. Maxwell's equations in differential and integral form for magnetostatics. The circulation theorem for magnetic induction. The magnetic field of a straight current and a solenoid.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
11	Fundamentals of magnetostatics. Relativity of electric and magnetic fields. Vector potential and its non-uniqueness. Vector potential of given currents. Analogy with electrostatics. The Biot–Savart law. Examples of calculating magnetic fields: the field at the centre of a ring, the field of a straight current-carrying segment.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
12	Fundamentals of magnetostatics. The field of a small loop. Magnetic dipole. Forces acting on a current loop. Mechanical energy of a loop in a magnetic field. Magnetic field in matter. Magnetization vector and its relation to the density of molecular currents. Magnetic field strength and its relation to magnetic induction.

Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
13	Magnetic field in matter. Boundary conditions at the interface of two magnetic materials. The field of a laboratory electromagnet. Magnetism of matter. Types of magnetic materials. Magnetism of individual atoms. Physics of ferromagnetism.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
14	Electromagnetic induction. The nature of electromagnetic induction. Faraday's law. Physics of electromagnetic induction. The alternating current generator.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.
15	Electromagnetic induction. Mutual induction. Mutual inductance coefficient. The reciprocity theorem. Self-induction. Inductance. Inductance of a solenoid.
Literature:	[2], [4]
Self-study:	Study of the lecture material. Problems.

PRACTICAL CLASSES

The main objective of the practical classes is for students to master techniques and methods for the practical application of knowledge.

To prepare for a practical class, the student should study the theoretical material on the topic. After the class, the student should complete the homework on problem solving.

No.	*Topic and main issues (teaching materials, references and self-study assignments)*
1	Electric field strength and potential.
Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.
2	Calculation of electric fields using Gauss's law.
Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.
3	Conductors. Capacitors. Field energy.
Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.
4	The field in dielectrics. Electric displacement vector.
Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.
5	Laws of electric current. The Biot–Savart law. Magnetic field of currents.
Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.
6	The effect of a magnetic field on a current. Calculation of the magnetic field in vacuum using the circulation theorem.
Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.
7	Magnetic field in matter.
Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.
8	Electromagnetic induction.

Literature:	[5],[6]
Self-study:	Problem solving. Worked examples. Problems for independent work.

LABORATORY CLASSES

In the second semester, students perform laboratory works from the "Electromagnetism" cycle according to the established schedule and timetable.

The main objective of the laboratory works is for students to gain experience in carrying out experimental research to verify theoretical statements and to learn the rules for processing experimental data and presenting the results.

To prepare for laboratory work, students should: 1) study the theory; 2) prepare the research protocol; 3) complete the virtual laboratory work; 4) pass a preliminary test to check their readiness for the laboratory work.

Each student performs 5 works from the list below (according to a schedule).

No.	*Title of the laboratory work (computer practicum)*
2-1	Determination of conductor resistance using a direct current bridge (Wheatstone bridge).
2-2	Measurement of electromotive force by the compensation method.
2-3	Determination of the capacitance of a capacitor by the ballistic galvanometer method.
2-4	Study of the electronic oscilloscope.
2-5	Study of the electrostatic field.
2-7	Study of thermoelectromotive force.
2-8	Study of thermionic emission.
2-9	Determination of the specific charge of the electron by the magnetron method.
2-11	Recording the magnetization curve and hysteresis loop of ferromagnets in alternating magnetic fields.
2-12	Measurement of the magnetic induction of an electromagnet.
2-13	Study of free damped oscillations in a circuit.
2-14	Study of forced oscillations in a series resonant circuit.

6. Student's independent work

Self-study in the second semester amounts to 78 hours. It includes: studying the lecture material and individual theoretical topics assigned for independent study, preparing for practical classes, solving homework problems, preparing for laboratory works, preparing for the modular control work (MCW), writing the MCW and preparing for the exam.

The lecture material is studied regularly throughout the semester before the next lecture by reviewing the lecture notes and the recommended literature. This takes 30 to 60 minutes.

Preparation for practical classes involves reviewing or studying the relevant theoretical material and going through worked examples on the topic. This takes 1 to 2 hours.

Homework problems are solved to consolidate the knowledge and skills of applying the theory acquired in class. This takes 1 to 3 hours.

Preparation for laboratory works involves studying the laws of physics verified in the experiments, the research methodology, the measuring instruments used and the procedure for processing the experimental results. This takes 1 to 3 hours. After the laboratory work, students must present the results: perform the necessary calculations, plot graphs and calculate the errors. The processed experimental data must be submitted no later than the next laboratory class.

Preparation for the MCW involves revising the theory and its practical application. This takes 1 to 6 hours.

Policy and Control

7. Course policy (educational component)

Attendance at lectures, practical classes and laboratory works is mandatory. In case of illness, the student must submit a certificate of the period of treatment, duly issued by the medical institution. In other cases (for example, family circumstances), the issue is resolved individually with the teacher. Attendance at lectures and practical classes, as well as absence from them, is not assessed. In any case, students are advised to attend all classes, since they present the theoretical material and develop the skills needed for current semester assignments, laboratory works and homework. The assessment system also provides for bonus points for activity in practical and laboratory classes.

The results of practical work are handwritten and accompanied by formulas and graphs that confirm the completion of the tasks and the results obtained.

In distance learning, practical work may be done by hand or in any text editor and may be submitted for checking in printed or electronic form. The defence takes the form of an interview with questions and answers.

During lectures, practical and laboratory classes, it is prohibited to use mobile phones for communication and unauthorised Internet searches. They may be used only for testing, for calculations in practical and laboratory classes and for measuring time in laboratory classes (if the smartphone has the appropriate software).

In distance learning, the lecturer uses their own presentation materials and Zoom and/or Google Meet for teaching and conducting practical classes.

To defend a laboratory work, the student must answer the control questions and present the measurement results correctly (calculate the required quantities, plot the graphs according to the rules, calculate the errors, write down the final results with correct rounding and draw conclusions).

Homework is done in a separate notebook and submitted by the deadline set by the teacher at the beginning of the semester. Homework must be neat and legible.

Bonus points are awarded for active work in practical and laboratory classes and for participation in faculty and university physics olympiads. The number of bonus points per semester does not exceed 6.

The deadline policy requires timely completion of assignments. All written work must be submitted and defended before the end of the theoretical study period of the semester. Penalty points are given for late homework and late defence of laboratory works.

A student who misses the MCW without a valid reason receives a zero result. In this case, the student may write the MCW at a time set by the teacher, but the maximum score will be 50% of the total. Rewriting the MCW is not allowed.

All participants in the educational process, teachers and students, must follow the policy and principles of academic integrity defined by the Code of Honour of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". More details: https://kpi.ua/code.

8. Types of control and the rating system for assessing learning outcomes (RSA)

In accordance with the regulations on the organization of the educational process in the spring semester of the 2025-2026 academic year under martial law, semester control will be held as a credit instead of an exam; the formula for converting the starting rating to the 100-point scale will be applied (in accordance with the "Regulations on Semester Control in Distance Mode").

The course rating takes into account the student's work during the semester and the level of knowledge and skills demonstrated at the exam. Students' work during the semester includes both classroom work and self-study. The course rating covers all types of work that students must complete during the semester under the rating system for assessing learning outcomes (RSA).

The course rating is formed as the sum of the points awarded to the student for:

– tasks in practical classes;

– homework on problem solving;

– laboratory works;
– the modular control work (MCW);
– exam tasks.

The course rating (R) is calculated as the sum of the points for current control during the semester (starting rating R_C) and the points received at the exam (R_E):

$$R = R_C + R_E .$$

The starting rating R_C is the sum of the rating points received for current control in practical classes (r_P), laboratory works (r_L) and the MCW (r_{MCW}):

$$R_C = \Sigma(r_P + r_L) + r_{MCW} .$$

The maximum starting rating is 50 points; the maximum number of points R_C received at the exam, R_E, is 50 points. The maximum total course rating for the semester R is 100 points.

The assessment criteria for work during the semester are given in Table 1, and bonus and penalty points in Table 2.

*In total, 6 laboratory works are performed during the semester; the maximum score for one laboratory work is 3.3 points.

The assessment criteria for work during the semester are given in Table 1, and bonus and penalty points in Table 2.

Table 1. Assessment criteria for work during the semester.

No.	*Control measures*	*Maximum number of points*
1	Homework on problem solving	20
2	Modular control work	10
3	Laboratory works	20
	Total	**50**

The modular control work (MCW) consists of handwritten solutions of problems with individual parameters. After completing the work, the student must send a photocopy of it to the class by the set time. MCW points are awarded according to the number of correct answers.

Table 2. Bonus and penalty points

Criterion	*Maximum number of points*
Active work in practical and laboratory classes	5
Participation in faculty and university physics olympiads and physics competitions	5
Late homework on problem solving (one week late) Late submission of 1 homework assignment (one week late)	-5 -0.5
Late defence of laboratory works (one week late) Late defence of 1 laboratory work (one week late)	-5 -0.5
Maximum sum of penalty and bonus points	**-5…5**

Additional points for completing the adaptation course in physics by IMYaO of Igor Sikorsky Kyiv Polytechnic Institute are awarded according to the points indicated in the certificate, after admission to the exam.

Semester control: **exam**.

Students are admitted to the exam if they have scored at least 30 points in current control during the semester (starting rating R_C of at least 30 points), provided that all laboratory works and all homework assignments have been completed and the modular control work has a positive result (at least 60% of tasks done correctly). At the exam, a student can score up to 50 points.

During semester control, students must comply with the requirements of academic integrity, moral and ethical standards of conduct and the rules on the materials they may use. If a student is found to have violated these requirements, the examiner has the right to remove the student from the exam.

The exam is audio- and video-recorded, and students' work with the results of the semester control tasks is kept.

During the online consultation, students are informed of:

– the procedure for the distance exam, the assessment criteria, the means of communication and the information tools to be used during the control measures;

– students' starting ratings;

– how compliance with academic integrity requirements will be monitored and the consequences of violating them;

– who has not been admitted to the exam and why.

An examiner conducting semester control remotely must ensure reliable identification (verification of identity) of the student. Otherwise, the student is considered not to have attended the semester control. Identification may be carried out, for example, by the student showing their record book or another identity document to the examiner via video link.

During an oral online exam, no more than 6 students may be present at the same time. Each student must be given at least 30 minutes to prepare an answer.

A written exam may be conducted:

– with handwritten completion of the exam paper tasks; in this case, 3-5 minutes before the end of the exam the student must sign each sheet, take a photocopy of the work and send it by the set time;

– with a fixed duration followed, if necessary, by a personal interview between the teacher and the student;

If current control makes it possible to determine unambiguously the level of the competences provided for by the curriculum, the final exam grade may be given by proportionally converting the semester points to the 100-point scale.

Table 3. Exam assessment criteria

Criterion	*Number of points*
The student demonstrates complete and deep knowledge of the material and can apply it correctly	45…50
The student demonstrates good knowledge of the material and can apply it correctly	30…45
The student demonstrates good knowledge of the material but makes some inaccuracies in applying it	25…35
The student demonstrates satisfactory knowledge of the material but makes significant inaccuracies in applying it	20…25
The student demonstrates satisfactory knowledge of the theory but makes significant errors in applying it	15…20
Unsatisfactory knowledge of the theory and lack of skills in solving the set problems	1…15

The maximum total course rating for the semester is 100 points; the minimum positive total rating is 60 points.

The correspondence between rating points and grades on the university scale is given in Table 4.

Table 4. Correspondence between rating points and grades on the university scale.

Student's rating score	*University grading scale*
95…100	Excellent
85…94	Very good

75…84	Good
65…74	Satisfactory
60…64	Sufficient
Less than 60	Unsatisfactory
Admission conditions for semester control not met	Not admitted

9. Additional information on the course (educational component)

Inclusive education

The course "Physics" can be taught to most students with special educational needs, except for students with serious visual impairments that prevent them from completing tasks using personal computers, laptops and/or other technical means.

The lecturer reserves the right to change the order of presentation of the material and, in part, its volume and content, depending on students' learning abilities and capacity to master it.

Working program of the academic discipline (syllabus):
Physics. Part 2.
Electrostatics, Electromagnetism, Atomic Physics

Compiled by Professor of the Department of General Physics and Modelling of Physical Processes Oksana Gorobets and Senior Lecturer of the Department Olha Kerita

Approved by the Department of General Physics and Modelling of Physical Processes (minutes No. 06-26 of 24.06.2026)

Agreed by the Methodical Commission of the Faculty of Robotics and Instrument Engineering (minutes No. 6/26 of 26.06.2026)