Physical Foundations of Multimedia Systems

Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	***First (bachelor)***
Branch of knowledge	*12 Information technologies*
Specialty	*121 Software engineering*
Educational program	*Software Engineering of Multimedia and Information Retrieval Systems*
Discipline status	*Normative*
Form of education	*Full-time*
Year of training, semester	*3rd year of training, 5th semester*
Scope of the discipline	*Lectures: 36 hours, practical classes: 18 hours, self-study: 66 hours.*
Semester control/ control measures	*Exam, modular control work, computational work*
Lessons schedule	*According to the schedule for the current academic year (rozklad.kpi.ua)*
Language of teaching	*English*
Information about	*Lecturer: Associate Professor Oleksandr Mykhailovych Neschadym, Ph.D*
head of the course / teachers	*Practical classes: Associate Professor Oleksandr Mykhailovych Neschadym, Ph.D*

Program of educational discipline

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

During training in the discipline "Physical Foundations of Multimedia Systems" students will receive theoretical training in the field of physics, will acquire the skills to correctly understand the limits of the application of physical concepts, laws and theories, which will allow them to further apply this knowledge in the development of multimedia systems that involve modeling the phenomena of physical of the world for realistic visualization, in particular immersive multimedia and multimedia environments. In practical classes, students will learn how to solve practical problems, in particular, how to use a mathematical apparatus to solve certain physical problems.

The purpose of the educational discipline "Physical Foundations of Multimedia Systems" is the formation of students' abilities to apply the basic principles and laws of classical and modern physics, to operate with fundamental physical concepts and laws when solving certain physical problems, to master the basic material for further study of the disciplines of the cycle of professional and practical training.

The subject of the educational discipline "Physical Foundations of Multimedia Systems" - fundamental laws of the movement of matter, its structure, properties and interaction.

*The discipline "Physical Foundations of Multimedia Systems" forms in students of education general (GC) and **specialist competences (PC):***
***GC02** Ability to apply knowledge in practical situations.*
***GC06** Ability to search, process and analyze information from various sources.*
***PC20** Ability to apply the acquired fundamental mathematical knowledge to develop calculation methods in the multimedia and information retrieval systems creation.*

The discipline "Physical Foundations of Multimedia Systems" forms in students the following ***program learning outcomes (PLO)*** *according to the educational program:*
PLO01 *To analyze, purposefully search and select the necessary information and reference resources and knowledge to solve professional problems, taking into account modern advances in science and technology.*
PLO25 *To know and to be able to use fundamental mathematical tools in the algorithm construction and modern software development.*

2. Pre-requisites and post-requisites of the discipline (place in the structural and logical scheme of training according to the relevant educational program)

The successful study of the discipline "Physical Foundations of Multimedia Systems" is preceded by the study of the discipline "Mathematical Support of Multimedia and Information Retrieval Systems", in particular, knowledge of the basics of integral and differential calculus.

The theoretical knowledge and practical skills obtained during the mastering of the discipline "Physical Foundations of Multimedia Systems" ensure the successful implementation of course and diploma projects in the specialty 121 Software engineering.

3. Content of the academic discipline

1. *Chapter 1. Kinematics*
2. *Topic 1.1. Kinematics of a material point*
3. *Topic 1.3. Kinematics of rotary motion*
4. *Chapter 2. Dynamics*
5. *Topic. 2.1. Dynamics of a material point*
6. *Topic 2.2. Dynamics of rotational motion of a rigid body*
7. *Topic 2.3. Laws of conservation*
8. *Topic 2.4. Relativistic mechanics*
9. *Chapter 3. Electrostatic field*
10. *Topic 3.1. Electrostatic field in vacuum*
11. *Topic 3.2. Electrostatic field in dielectrics and conductors*
12. *Chapter 4. Electrodynamics*
13. *Topic 4.1. Direct current*
14. *Topic 4.2. Direct current magnetic field*

4. Educational materials and resources

Basic literature:

1. Weidner, Richard Tilghman and Brown, Laurie M. Physics. Encyclopedia Britannica, 11 Jan. 2023, URL: https://www.britannica.com/science/physics-science.

2. Kingslake, Rudolf and Thompson, Brian J. Optics. Encyclopedia Britannica, 16 Feb. 2023, URL: https://www.britannica.com/science/optics.

3. Scace, Robert I.. Electronics. Encyclopedia Britannica, 2 Jun. 2020, URL: https://www.britannica.com/technology/electronics.

Educational content

4. Methods of mastering an educational discipline (educational component)

№	Type of training session	Description of the training session
1	*Lecture 1. Kinematics of a material point*	*Introduction. Mechanical movement. Reference system. Kinematic description of movement. Trajectory, path and movement. Speed.* *Tasks on self-study: item 6, number 1.*
2	*Lecture 2. Kinematics of a material point*	*You mean displacement due to speed. Way. Average speed. Acceleration. Determination of speed through acceleration. Normal and tangential components of acceleration.* *Tasks on self-study: item 6, number 2.*
3	*Laboratory lesson 1*	*Theory of errors and processing of measurement results in a physical laboratory.* *Assignment on self-study: item 6, number 3.*
4	*Lecture 3. Kinematics of a material point*	*Movement in a circle. Angular movement. Angular velocity. Rotation period. Rotational frequency. Angular acceleration.* *Tasks on self-study: item 6, number 4.*
5	*Lecture 4. Dynamics of a material point*	*Galileo's principle of relativity. Newton's first law. Inertial reference systems. Mass and force. Newton's second law. Adding forces. Newton's third law.* *Tasks on self-study: item 6, number 5.*
6	*Laboratory lesson 2*	*Elastic properties of bone tissues* *Tasks on self-study: item 6, number 6.*
7	*Lecture 5. Dynamics of rotational motion of a rigid body*	*A moment of power. Moment of impulse. The equation of rotational motion of the body (general view). Moment of inertia. The basic equation of rotational motion.* *Tasks on self-study: item 6, number 7.*
8	*Lecture 6. Laws of conservation*	*Mechanical work. Power. Potential energy. The relationship between potential energy and force. Kinetic energy. Pulse. Laws of conservation of momentum, moment of momentum, mechanical energy.* *Tasks on self-study: item 6, number 8.*
9	*Laboratory lesson 3*	*Study of the dynamics of the simplest systems using the Atwood machine.* *Tasks on self-study: item 6, number 9.*
10	*Lecture 7. Relativistic mechanics*	*Galilean transformations and the principle of relativity of classical mechanics. Postulates of the special theory of relativity. Lorentz transformation. Shortening lengths and slowing down time. Speed conversion. Light speed limit. Relativistic momentum. The equation of motion of a relativistic particle. Kinetic energy of a relativistic particle, Einstein's formula.* *Tasks on self-study: item 6, number 10.*
11	*Lecture 8. Electric field of charges in a vacuum*	*Electric charge. Electric field, field intensity vector. Point charge field. The principle of superposition. Coulomb's law.* *Tasks on self-study: item 6, number 11.*
12	*Laboratory session 4*	*Rotational motion of a solid body* *Tasks on self-study: item 6, number 12.*

13	*Lecture 9. Electric field of charges in a vacuum*	*Vector field flow. Gauss' integral electrostatic theorem for the field in a vacuum. Application of the Gauss theorem for the calculation of electric fields.* *Tasks on self-study: item 6, number 13.*
14	*Lecture 10. The electric field of charges in a vacuum*	*Work on moving a charge in an electrostatic field. Potential nature of the electrostatic field. Potential difference and potential. The relationship between the potential and the intensity of the electrostatic field.* *Tasks on self-study: item 6, number 14.*
15	*Laboratory lesson 5*	*Study of the rotational motion of a solid body and determination of the ball's flight speed using a rotating pendulum* *Tasks on self-study: item 6, number 15.*
16	*Lecture 11. Electric field in dielectrics and conductors*	*Dielectrics and conductors. Macroscopic field in matter. Electric dipole. Polarization of dielectrics, polarizing (bound) charges, polarizability. Electric displacement vector, Gauss's theorem for the electric field in the presence of a dielectric.* *Tasks on self-study: item 6, number 16.*
17	*Lecture 12. Electric field in dielectrics and conductors*	*The field in an isotropic dielectric, dielectric susceptibility and permeability. Conditions at the boundary of two dielectrics. A conductor in an external electric field. Protection of electrical devices from the influence of external electromagnetic fields.* *Tasks on self-study: item 6, number 17.*
18	*Laboratory lesson 6*	*Determination of conductor resistance using a constant current bridge.* *Tasks on self-study: Item 6, No. 18.*
19	*Lecture 13. Electric field in dielectrics and conductors*	*Electrical capacity, capacitors. Application of capacitors in modern computers. Localization of electrostatic energy, volume density of electric field energy.* *Tasks on self-study: Item 6, No. 19.*
20	*Lecture 14. Laws of direct current*	*Current magnitude and density, current lines. Electric circuits. External forces, voltage drop and electromotive force (EMF). Resistance, parallel and series connection of resistors, temperature dependence of resistance.* *Tasks on self-study: Item 6, No. 20.*
21	*Laboratory lesson 7*	*Measurement of electromotive force by the method of compensation* *Tasks on self-study: item 6, number 21.*
22	*Lecture 15. Laws of direct current*	*Ohm's law for an arbitrary section of a circle. Branched circles, Kirchhoff's rules. Ohm's and Joule-Lenz's laws in differential form.* *Tasks on self-study: item 6, number 22.*
23	*Lecture 16. Magnetic field*	*Magnetic interaction, magnetic induction vector. Magnetic field of a conductor with a current. Biot-Savard's law, Ampere's law, Gauss's theorem and the theorem on the circulation of the magnetic field of currents. Magnetic field in matter.* *Tasks on self-study: Item 6, No. 23.*
24	*Laboratory session 8*	*Determination of capacitor capacity* *Tasks on self-study: Item 6, No. 24.*
25	*Lecture 17. Magnetic field*	*Work on moving a current-carrying conductor in a magnetic field. Magnetic flux. The phenomenon of electromagnetic induction. Faraday's law. Maxwell's system of equations for a complete description of the electromagnetic field.* *Assignment on self-study: Item 6, No. 25.*

26	*Lecture 18.*	*Modular control work* *Tasks on self-study: Item 6, No. 26.*
27	*Laboratory lesson 9*	*Study of the electrostatic field* *Tasks on self-study: Item 6, No. 27.*

5. Independent work of a student/graduate student

The discipline "Physical Foundations of Multimedia Systems" is based on independent preparation for classroom classes on theoretical and practical topics.

№z/p	*The name of the topic submitted for independent processing*	*Number of hours*	*literature*
1	*Preparation for the lecture 1*	*1*	*1-3*
2	*Preparation for the lecture 2*	*1*	*1-3*
3	*Preparation for laboratory session 1*	*1*	*1-3*
4	*Preparation for the lecture 3*	*1*	*1-3*
5	*Preparation for the lecture 4*	*1*	*1-3*
6	*Preparation for laboratory session 2*	*1*	*1-3*
7	*Preparation for the lecture 5*	*1*	*1-3*
8	*Preparation for the lecture 6*	*1*	*1-3*
9	*Preparation for laboratory session 3*	*1*	*1-3*
10	*Preparation for the lecture 7*	*1*	*1-3*
11	*Preparation for the lecture 8*	*1*	*1-3*
12	*Preparation for laboratory session 4*	*1*	*1-3*
13	*Preparation for the lecture 9*	*1*	*1-3*
14	*Preparation for the lecture 10*	*1*	*1-3*
15	*Preparation for laboratory session 5*	*11*	*1-3*
16	*Preparation for the lecture 11*	*1*	*1-3*
17	*Preparation for the lecture 12*	*1*	*1-3*
18	*Preparation for laboratory session 6*	*1*	*1-3*
19	*Preparation for the lecture 13*	*1*	*1-3*
20	*Preparation for the lecture 14*	*11*	*1-3*
21	*Preparation for laboratory session 7*	*1*	*1-3*
22	*Preparation for the lecture 15*	*1*	*1-3*
23	*Preparation for the lecture 16*	*1*	*1-3*
24	*Preparation for laboratory session 8*	*1*	*1-3*
25	*Preparation for the lecture 17*	*1*	*1-3*
26	*Preparation of modular control work*	*10*	*1-3*
27	*Preparation for laboratory session 9*	*1*	*1-3*
28	*Preparation for the exam*	*30*	*1-3*

Policy and control

6. Policy of academic discipline (educational component)

- *Questions at lectures are asked in the time allotted for this purpose;*
- *modular test papers are written without the use of auxiliary means (mobile phones, tablets, etc.), the result is uploaded to Google Class;*
- *incentive points are awarded for: active work in practical classes; participation in faculty and institute physics olympiads. The number of encouraged points is up to 5;*
- *points received at official auxiliary courses of KPI named after Igor Sikorsky for the study of the discipline of Physics, provided that the relevant certificate is presented.*

7. Types of control and rating system for evaluating learning outcomes (RSO)

A student's rating consists of the points he receives for:
1) laboratory work;
2) modular control work;
3) performance and protection of settlement work.

***Number of laboratory works**– Each laboratory work is evaluated in 1 point. Points for completing tasks are calculated as follows:*
- the work was completed and designed flawlessly, the student gave full answers to all theoretical questions related to the topic of the work - 1 point.
- work not completed - 0 points.

***Modular control work** consists of 3 problems, each of which is valued at 6 points. A student can get a maximum of 18 points for a modular test. The minimum number of points under which the test is considered passed is 9. Points for completing tasks are calculated as follows:*
- a completely correct solution to the problem (correct design of given quantities with transfer to the SI system and a formulated question, a clear schematic drawing indicating the directions of vector quantities, if necessary, a correct physical solution to the problem, calculation of an unknown quantity without errors, recorded units of measurement for all physical quantities) – 6 points;
- the solution of the problem was performed with errors at the level of mathematical calculation of an unknown quantity and incorrect use of dimensions - 5 points;
- the solution of the problem is partially completed: the main formulas and laws are written correctly, but errors occurred in the transformation of the formulas and because of this the physical solution turned out to be incorrect - 4 points;
- there is no solution to the problem, but the main formulas and laws necessary for it are written down - 3 points;
- there is no solution to the problem, there are no physical formulas, but the correct design of the specified values with the translation to the SI system and the formulated question, as well as a clear schematic drawing with the direction of the vector values - 2 points;
- there is no solution to the problem, there are no physical formulas and a schematic drawing, but the correct design of the specified values with the translation to the SI system and the formulated question are completed - 1 point;
- the absence of any records regarding the task and the solution or errors in the record of given values - 0 points.

***Computational work** consists in performing the necessary calculations and constructing a graph based on the received data. The maximum score for performing calculation work is 23 points. At the same time, the student receives:*
- 23 points in the case of perfect execution or the presence of minor mistakes;

19-22 points in case of minor errors in numerical values or incorrectly used dimensions or not all specified information on the graph;
14-18 points in the case of an error in the formulas during calculations, which leads to an incorrect appearance of the graph;
- less than 14 points (in this case, the work is considered uncredited), if the data is not calculated to the end, or there is no schedule.

Semester component *rating scale RS = 50 points, it is defined as the sum of points received for the performance and defense of laboratory work, modular control work, calculation work.*
RS = $R_{lab.\ work.}$ + $R_{Modular\ control\ work}$ + $R_{computational\ work}$ = 9 points + 18 points + 23 points = 50 points.

Composition and evaluation criteria of the exam answer:
The examination ticket consists of 2 questions - 1 theoretical and 1 practical.

Examination component *rating scale RE =50 points.*
These points can be obtained as follows: for a theoretical task - from 0 to 20 points, for a practical task - from 0 to 30 points.

Evaluation criteria for the practical question of the examination work:
28-30 points – full disclosure of the content of the topic and good answers to clarifying questions;
24-29 points – disclosure of the content of the question with minor errors or some incorrect answers to clarifying questions;
20-23 points – incomplete disclosure of the content or most of the answers to teaching questions are incorrect;
17-19 points – written work and answers to questions contain gross errors;
0-16 points - no answer or the answer does not correspond to the content of the question.

Evaluation criteria for the theoretical question of the examination paper:
18-20 points – full disclosure of the content of the topic and good answers to clarifying questions;
15-17 points – disclosure of the content of the question with minor errors or some incorrect answers to clarifying questions;
12-14 points – incomplete disclosure of the content or most of the answers to the teacher's questions are incorrect;
6-11 points – written work and answers to questions contain gross errors;
0-5 points - no answer or the answer does not correspond to the content of the question.
The maximum number of points for an answer on the exam:
RE = 30 + 20 = 50 points.
The rating scale for the discipline is equal to: R = RS + RE = 50 points + 50 points = 100 points
Semester control: exam.
A prerequisite for admission to the exam is the completion and defense of all laboratory work.

Table 1. Correspondence of rating points to grades on the university scale

Scores	*Rating*
100-95	Perfectly
94-85	Very good
84-75	Fine
74-65	Satisfactorily
64-60	Enough
Less 60	Unsatisfactorily
Admission conditions not met	Not allowed

8. Additional information on the discipline (educational component)

Working program of the academic discipline (syllabi):

Adopted by Computer Systems Software Department (protocol № 12 from 26.04.23)

Approved by the Faculty Board of Methodology (protocol № 10 from 26.05.23)