National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of General Physics

PHYSICAL FOUNDATIONS OF COMPUTER SYSTEMS

Working program educational disciplines (Syllabus)

Props educational disciplines	
Cycle of Higher Education	**First cycle of higher education (Bachelor's degree)**
Field of Study	12 Informational technologies
Specialty	121 Software Engineering
Education Program	Computer systems Software Engineering
Type of Course	Normative
Mode of Studies	Daytime
Year of studies, semester	Second year, spring semester
ECTS workload	4 credits, 120 hours, Lectures 36 hours, Laboratory 18 hours, Self-study 66 hours
Testing and assessment	Final test / Module control test
Course Schedule	http://roz.kpi.ua
Language of Instruction	English
Head of the Course / Instructors	Head of the course: Professor, Dr. Sc. Yuri Gordienko, yuri.gordienko@gmail.com Senior lecturer, PhD, Gennadiy Lavanov, Lavanov.gennady@ukr.net +38(095)422-49-93
Access to the course	https://campus.kpi.ua https://do.ipo.kpi.ua

Program of academic discipline

1. Description of the discipline, goal, subject and the results teaching

Description of the discipline. During studies, students receive theoretical training in the field of the course of general physics, and get acquainted with the underlying physical processes and phenomena computer work, computer systems that are widely used in everyday life. They acquire the skills to correctly understand the limits of the application of physical concepts, laws and theories, what allow in in the future orientate in streams scientific and technical information On in laboratory work, students get acquainted with physical phenomena that have direct relation to physical which processes are happening in computer systems

The Subject: fundamental laws of movement matter, her building, properties of its interaction.

Interdisciplinary relationships. Discipline "Physical Foundations of Computer Systems" are logical continuation and deepening course elementary physics, what studied in general education educational institutions and has close communication with such disciplines as: higher math and philosophical foundations scientific knowledge.

The purpose of the discipline. The main goal educational disciplines consists of in familiarization and application basic laws modern physics in work computer systems Operate fundamental physical concepts and laws when solving certain applied physics tasks, master basic material for further study discipline cycle professionallypractical preparation

According to the educational and professional program, the discipline provides **professional competences**:
PC16 Ability to develop mobile systems, embedded systems and real-time systems
and **program learning outcomes**:
PLO26 Know principles buildings and functioning highly productive computer systems

The main tasks of the academic discipline

Knowledge:

- content basic laws electrostatics;
- content basic laws electric current;
- content basic electromagnetic laws fields;
- content basic laws geometric and wave optics;
- content basic laws atomic physics;
- content basic laws and provisions quantum mechanics;
- content basic laws solid state physics bodies;

Skills:

- analyze physical phenomena;
- apply physical phenomena in work in computer systems;
- apply mathematical apparatus for solution certain physical tasks;
- analyze educational and methodological literature, use it ineducational process;
- analyze and interpret received the results received in go experiments;

Experience:

- understand work computer systems using physical laws and phenomena;
- to gain the ability to acquire knowledge independently, using modern educational and informative technologies;
- right use general science and special terminology

2. Prerequisites and post-requisites of the discipline (place in the structural and logical schemeteaching according to the corresponding educational program)

Prerequisites: basic knowledge with school course physics, mathematical knowledge analysis

Post-requisites: "Computer Systems and Networks Fundamentals", " Philosophical Foundations of Scientific Cognition".

3. Structure of the credit module

Discipline structurally divided on 5 sections

Section 1. Foundations electromagnetic processes in computer systems:

1.1. Electric field charges

1.2. Examples calculation electric fields.

1.3. Electric field in substances

1.4. Magnetic field currents

1.5. Electromagnetic induction. Equation electromagnetic fields

Section 2. Fluctuating and wave processes in computer systems:

2.1. Electric fluctuation. Wavy processes.

Section 3. Optical and physical visualization basics data in computer systems:

3.1. Geometric optics.

3.2. Interference light

3.3. Diffraction light waves

3.4. Polarization light

Section 4. Physics atom and basics quantum computing:

4.1. Photons. Photo effect. Lasers.

4.2. Physical foundations devices reflection information

4.3. Equation Schrodinger.

4.4. Particle in potential pit.

Section 5. Elements physics solid bodies computer systems:

5.1. Elements and the main ones concept zone theories.

5.2. Diodes and transistors

5.3. Application semiconductors in devices memory liquid crystals and their application incomputer systems

5.4. Magnetic properties solid bodies

4. Educational materials and resource

Basic:

1. O.V Dimarova, V.M. Kalita, S.O. Reshetnyak General Physics. Electrodynamics. Modularteaching. - K.: NTUU "KPI", 2021.
2. Kucheruk I.M., Gorbachuk I.I., Lutsik P.P. General course of physics.– To: Machinery, 1999, t 2.
3. Kucheruk I.M., Gorbachuk I.I., Lutsik P.P. General course of physics.– To: Machinery, 1999, t 3.
4. Tasks from general physics Section "Electricity and magnetism". Structure.: IN. P. Bryginets, AT. AT.Gusev, AT. V. Dimarova and others – K.: NTUU "KPI", 2019.

Supplementary:

5. Kravchuk S.O. Foundations computer techniques, Components, systems, network : Education Manual. –K. : Caravela, 206. – 344p

Educational content

5. Method mastery educational disciplines (educational component)

Educational part disciplines composed with lecture material, practical classes and laboratory works At teaching disciplines is recommended build familiarization students with the subject in such a way that they not only receive this or that information concerning course, which is studied but and felt communication between different topics credit module, and also place module among others physical discipline General methodical approach to teaching of an academic discipline is defined as communicative-cognitive and professional oriented, according to which the center of the educational process is the student - the subject of study and future specialist.

Lectures

No s/p	Name topics lectures and list basic questions (list didactic means, link on literature and task on self-study)
1	**Lecture 1. Basic concepts of the physics of computer systems.** Electric charge. Law Coulomb. Electric field, field intensity vector. Point charge field. Principle superpositions. Potential difference and potential. The relationship between potential and tension electrostatic fields Literature: [1], 1.2 – 1.5; [2], 1.1 – 1.6.
2	**Lecture 2. Electric field in substance** Flow vector fields Calculation electric field. Conductors Macroscopic field in matter. Electric dipole. Polarization dielectrics, polarizing (connected) charges, polarization. Vector electric bias. Literature: [1], 1.6 – 1.13; [2], 1.7, 1.14.
3	**Lecture 3. Application capacitors in computer systems** Field in dielectric, dielectric susceptibility and permeability. Conductor in external electric poly. Electric capacity, capacitors. Energy electric fields Physical basics of work input devices information Literature: [1], 2.1 – 2.6; [2], 1.15 – 1.18.
4	**Lecture 4. Magnetic field currents** Current. Law Ohm. EMF. Magnetic interaction, magnetic induction. Magnetic field of a conductor with a current, Biot-Savar law. Interaction magnetic fields with current Nature magnetism substances Magnetization and magnetization. Magnetization isotropic magnet, magnetic susceptibility and permeability. Magnetic field in substance, tension vector magnetic fields Literature: [1], 3.1 – 3.7; [2], 2.1, 2.2, 2.4.8.1 - 8.4.
5	**Lecture 5. Electromagnetic induction. Electromagnetic field equation.** Phenomenon electromagnetic induction Rule Lenz Law Faraday. Inductance outline, self induction Energy magnetic fields Vortex electric field. Equation Maxwell. Literature: [1], 4.1 - 4.11; [2], 5.1, 5.4.
6	**Lecture 6. Oscillatory and wave processes in the physics of computer systems.** Kinds fluctuations Harmonious fluctuation, their differential equation. free fading oscillations in the circuit, amplitude and frequency of damping oscillations. Forced fluctuations in contour Amplitude characteristics of the circuit, resonance. AC. Active and reactive supports, impedance Equation and characteristics monochromatic waves. Wavy surface and phase speed. Formation and general properties electromagnetic waves Literature: [2], 12.1 –12.3, 13.1 – 13.3, 14.1 – 14.2.
7	**Lecture 7. The main ones laws geometric optics physics computer systems** Geometric optics. The main ones laws geometric optics Refractive index. Law of refraction and reflection light rays. Collection lens. Scattering lens.Building images in lenses Application lenses in computer technology. Literature: [3], 2.2 -2.4.

8	**Lecture 8. Interference of light.** Light waves. Concept of interference and coherence Maximum and minimum conditions. Ways of observing interference light Interference in thin plates Interferometers. Literature: [3], 3.1 -3.6.
9	**Lecture 9. Diffraction of light waves.** The Huygens-Fresnel principle. Diffraction Fraunhofer on one cracks Diffraction Fraunhofer on one-dimensional lattice Application phenomena diffraction in computer techniques Literature: [3], 4.1–4.4.
10	**Lecture 10. Polarization light** Polarized and natural light. Kinds polarization. Law Malus. Polarization at reflections from dielectric Law Brewster. Law complete internal reflection. Physical processes in optical fibers and light conductors Literature: [3], 2.11, 5.1 - 5.5.
11	**Lecture 11. The main ones laws atomic physics computer systems:** Quantum hypothesis. photons, energy and pulse photons Photo effect. Principle uncertainty Heisenberg. Forced radiation. The principle of laser operation. Semiconductors lasers Application semiconductor lasers in computer techniques and devices Literature: [3], 9.1 -9.5, 13.12 – 13.13.
12	**Lecture 12. Physical foundations of information display devices:** Nano-tubes. Fullerenes. The concept of quantum dots. The principle of operation of the monitor. Principle of operation projector. The principle of the printer. Literature: [9], 3.1 -3.6.
13	**Lecture 13. The main ones laws and to postulate quantum physics in computer systems:** Corpuscular-wave dualism. Equation Schrodinger. Principle superpositions became postulate quantum mechanics Khvylova function. Particle in one-dimensional potential pits: endlessly deep pit, pit finite depth Quantum computer. Basics of construction quantum computers Literature: [3], 12.2 -12.4.
14	**Lecture 14. An electron in a potential well:** Reflection and passage by a particle potential barrier. Potential barrier finite width Particle in potential box. A particle in a potential well. Linear harmonic oscillator. Normal and the excited state of the oscillator. Literature: [3], 12.5 -12.6.
15	**Lecture 15. Elements and basic concepts of band theory** : Types of communication in crystals. Basic concepts of the zone theory of solids. Conductors, dielectrics. Transition metal - metal. Semiconductors. Literature: [5], 13.64 -13.65
16	**Lecture 16. Diodes and transistors:** pn junction. Diodes. Dinisters. pnp LEDs and npn transistors Field transistors Application transistors for structures logical computer elements. Literature: [5], 13.66 -13.69
17	**Lecture 17. Application of semiconductors in memory devices. Liquid crystals and their application in computer systems:** RAM devices on base semiconductor techniques liquid crystals Properties liquid crystals Application liquid crystals in computer systems Literature: [7], 1.1, 4.1, 5.1.

18	**Lecture 18. Magnetic properties solid bodies:** Ferromagnets. Diamagnetics. Paramagnets. Domains. Domain structure. Use of magnets in the computer room techniques Literature: [2], 9.2, 9.4 – 9.5, 9.8, 9.10 - 9.11.

Laboratory works

No s/p	Laboratory works names
1	Study electrostatic fields
2	Definition containers capacitor method ballistic galvanometer.
3	Study hysteresis ferromagnetic materials
4	Study interference light
5	Study diffraction Fraunhofer on cracks
6	Study polarized light at reflections from dielectrics.
7	Research impact temperature on conductivity metals and semiconductors.
8	Study external photo effect
9	Study spectra absorption and radiation semiconductors.

6. Self-study work

Student self-study work is the main means assimilation educational material in freefrom educational class time and includes

No s/p	Kind of work	Volume (hours)
1	Preparation for laboratory classes	46
2	Preparation for modular control work	10
3	Preparation for final test	10

Attendance Policy and Assessment

7. Policy of the educational discipline

System requirements, which teacher puts before student:

- **rules visiting classes** : in accordance to order 1-273 from 14.09.2020 p. prohibited evaluate presence or absence acquirer on auditorium occupation in ago number of to count encouraging or penalties points In accordance to RSO given disciplines points count by relevant species educational activity on practical classes
- **rules of behavior in classes** : the student must properly follow the teacher's instructions regarding work on occupation behave restrained and politely and not interfere others students and teacher Using means connection for search information on google drive teacher, in internet, in remote courses on platform Sikorsky is carried out by conditions instructions teacher;
- **policy of academic integrity** : Code honor National technical university of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" https://kpi.ua/files/honorcode.pdf establishes general moral principles rules ethical

behavior persons and provides politics academic integrity for persons what are working and study at the university, which they should be guided by in their own activities, including studies and drafting control measures with disciplines "Physical Foundations of Computer Systems";

- **when using digital means of communication with the teacher** (mobile communication, electronic mail, correspondence on forums and social networks, etc.) must be observed generally accepted ethical norms in particular be polite and limit communication workerssometimes the teacher

8. Monitoring and control

Calendar control : is conducted twice on semester as monitoring current state implementation syllabus requirements.

Modular control work (MCW)

Conditions admission to semester control : successful implementation control work, protection laboratory works, semester rating no Less 30 points.

In the first lesson, students get acquainted with the rating system of evaluation (RSO) disciplines, which built on basis "Position about system assessment resultsteaching", https://document.kpi.ua/files/2020_1-273.pdf .

System of rating points and evaluation criteria

1. The rating of the student from the credit module is calculated from 100 points. This rating (during semester) consists of the points that the student gets for nine (9) laboratory works plus modular control work result.

2. Criterion accrual points for laboratory work:

Weight score - 6 points. The maximum number of points for all laboratory work is 6 × 12 = 54 points.

Evaluation criteria:

creative work	6 points
work done with insignificant disadvantages	3 - 5 points
work performed with certain mistakes	2 points
work is not accepted (task not done or is rough errors)	0-1points

Criterion accrual points by modular control work (MCW): maximum score is 46 points

Criteria assessment:

creative work	40 - 46 points.
work done with insignificant disadvantages	29 - 39 points
work performed with certain mistakes	19 - 28points.
work is not accepted (task not done or is rough errors)	0-18 points

3. By condition the first attestation is protection 4 laboratory works By condition the second attestation – protectionthe last ones 5 laboratory works and implementation modular control work on time attestation

4. By condition offset is successful implementation everyone laboratory works, and also receiving not Less 12points by MCW.

5. Sum starters points and points by homemade control work is translated to creditevaluations according to table:

Score	Grade
100...95	Exellent
94...85	Very good
84...75	Good
74...65	Satisfactory
64...60	Sufficient
Less than 60	Fail
IS not counted control work or start rating less than 30 points	Not graded

9. Additional information

- The list of questions is given in the Electronic Campus and in the folder course on the Sikorsky platform.
- Certificates passage remote or online courses by appropriate subjectmay be enrolled subject to the fulfillment of the requirements specified in ORDER No. 7-177 OD 01.10.2020 "On the approval of the provision on recognition in Igor Sikorsky Kyiv Polytechnic Institute training outcomes acquired for informal education".

Syllabus of the course:
designed by Senior Lecturer of the Department of General Physics, Ph.D. Yuri Lavanov
adopted by Department of Computer Engineering (protocol № 10, 25.05.2022)
approved by the methodical commission of FICT (protocol № 10, 09.06.2022)