PROGRAM of the course "General Physics"
for group 141-5-18
The 1st term

Introduction

1. Subject of physics. Physical methods of research, experiment, hypothesis, theory. The concept of physical models. Physics role in the development of technology and the impact of technology on the development of physics. Computers and mathematical modeling in modern physics.
2. The relationship of physics to philosophy and other sciences. The common structure and objectives of physics studying.

Physical fundamentals of mechanics

Theory

Introduction to Mechanics

3. Subject of mechanics. Classical, relativistic and quantum mechanics. The concept of the mechanical movement. Frame of reference. Classical conceptions of space and time.

Elements of kinematics

4. Kinematics of a material point. Displacement, distance. Velocity and acceleration as radius- vector derivatives with respect to time. Normal and tangential acceleration.
5. Kinematics of solid. Translational and rotational motions. Angular velocity and angular acceleration, their relationship to linear ones.

The dynamics of a material point and the translational motion of solid.

Forces in mechanics

6. Newton's first law and inertial frame of reference.
7. Mass, momentum. The major task of classical mechanics. Force.
8. Newton's second law as an equation of motion. Force as the derivative of the point momentum with respect to time. Newton's third law.
9. The system of material points. Center of inertia. Theorem about the center of inertia motion.
10. *Forces in mechanics. Elasticity forces, Hooke's law. Friction forces.*
11. *The forces of gravitation, law of universal gravitation. Body weight. The concept of weightlessness. .*

The dynamics of a rigid body which has a fixed axis of rotation

12. Point and rigid body moment of inertia relative to the axis.
13. Force moment and angular momentum of the particle in respect to the axis. Angular momentum of a rigid body in respect to the axis. Moments equation.
14. Motion equation of a rigid body which has a fixed rotation axis. Force moment as the derivative of the body angular momentum with respect to time.

Conservation laws

15. Conservation laws and the solution of the major task of mechanics. Conservation laws and space and time symmetry properties.
16.The law of conservation of momentum, its relationship to Newton's third law. The law of conservation of momentum as a fundamental nature law. Reactive motion.
17. Work of alternative force. The power. The work of elasticity, gravity and friction forces. The concept of conservative forces and conservative system.
18. Energy as a general motion and interaction measure. Mechanical energy. The kinetic energy of the particle and systems of the particles. The kinetic energy of a rigid body with a fixed rotation axis and of the plane motion.
19. The potential energy of a conservative system. Total mechanical energy. Law of

energy conservation in mechanics as a special case of a general law of energy conservation and transformation.

20. *Applying of the laws of energy and momentum conservation to elastic and inelastic collisions.*

21. The law of angular momentum conservation. The concept of the gyroscopic effect, its usage in the automatic systems.

Elements of the special relativity theory

22. The relativity principle in classical mechanics. Galilean transformations. Velocities addition law in Newtonian - Galilean mechanics. The conception of the Galilean invariants.

23. Concept of simultaneity analyzis. Einstein's postulates. Lorentz transformations.

24. Relativistic addition law of velocities. Relativity of length and time. The interval between events, its invariance.

25. Mass and momentum of the relativistic particle. Relativistic motion equations. Newtonian - Galilean mechanics as a limiting case of a relativistic mechanics..

26. Kinetic energy, self-energy and total energy of the relativistic particle. The conception of the coupling energy of the relativistic system.

Tests on theoretical material

Laboratory workshop on physical principles of mechanics,.

Control tasks to independent work on physical principles of mechanics /7/

№ п/п	Individual task №1	№ п/п	Individual task №1
1.	Option 1	**17**	Option 7
2.	Option 2	**18**	Option 8
3.	Option 3	**19**	Option 9
4.	Option 4	**20**	Option 10
5.	Option 5	**21**	Option t
6.	Option 6	**22**	Option 2
7.	Option 7	**23**	Option 3
8.	Option 8	**24**	Option 4
9.	Option 9	**25**	Option 5
10	Option 10	**26**	Option t 6
11	Option 1	**27**	Option 7
12	Option 2	**28**	Option 8
13	Option 3	**29**	Option 9
14	Option 4	**30**	Option 10
15	Option 5	**31**	Option 1
16	Option 6	**32**	Option 2

Electrodynamics

Electrostatics

27. Electric charge, its discretion. Charge conservation law. Coulomb law.
28. Electrostatic field and its strength. The point charge field. The superposition principle and its application to calculation of the field strength of arbitrary charges configuration.
29. Graphic representation of an electrostatic field. Electrostatic field strength lines. Flux of the electrostatic field strength lines.
30. Gauss theorem for the electrostatic field strength vector and its application.
31.The work performed when a point charge moves in an electrostatic field; potential. The circulation of the electrostatic field strength vector. The electrostatic field potential character.
32. Equipotential surfaces. Connection of the field strength with potential.
33.The electrostatic field in dielectrics. Dielectrics polarization.
34. Ferroelectrics. Piezoelectric effect and its application.
35.Conductors in the electrostatic field. Electrostatic screening.
36. Conductor and capacitor electrocapacity.
37. Energy and volume energy density of the electrostatic field.

Direct electric current

38. Conditions of a direct electric current existence. Current strength and current density. Electric field of a direct current.
39. Exstraneous forces. Electromotive force and voltage.
40. *Ohm's law in integral and differential forms. Kirchhoffs rules and their application.*
41. Work and power of an electric current. Joule's law in integral and differential forms. 42.
42. Electric current in gases, ionization and recombination. The concept of the plasma. Thermoelectronic emission; electrovacuum devices.

Tests on theoretical material

Laboratory workshop on electrodynamics I

Control tasks to independent work on electrodynamics /7/.

№ п/п	Individual task №3, Problems 1–4	№ п/п	Individual task №3 Problems 1–4 ,
1.	Option 1	**17**	Option 7
2.	Option 2	**18**	Option 8
3.	Option 3	**19**	Option 9
4.	Option 4	**20**	Option 10
5.	Option 5	**21**	Option 1
6.	Option 6	**22**	Option 2
7.	Option t 7	**23**	Option 3
8.	Option 8	**24**	Option 4
9.	Option 9	**25**	Option 5
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16	Option 6	**32**	Option 2

Stationary magnetic field

43. Field of moving charge. Magnetic field and its relativistic origin.
44. Action of magnetic field on the conductor with current. Ampere's law. The magnetic field induction. .
45. Circuit with a current in the magnetic field. Magnetic moment of the circuit with a current. The electric motor action.
46. Lorentz force. Motion of charged particles in the magnetic field. Hall effect and its application.
47. Law of Biot - Savart - Laplace for current element and its application to the calculation of the fields of the simplest configurations of currents. Field of straight and circular currents.
48. Circulation of magnetic induction vector. Vortex nature of the magnetic field. The solenoid magnetic field.
48. The flux of a magnetic induction vector. Gauss theorem for a magnetic induction vector.
49. Work performing by moving the conductor and the circuit with a current in the magnetic field.

Magnetic field in matter

50. Types of magnets. Magnetic field strength. Magnetization. The failure of classical explanation of the matter magnetic properties.
51. Ferromagnets and their properties. Application of ferromagnets.

The phenomenon of electromagnetic induction. The basics of Maxwell's theory of electromagnetic field

52.Faraday's experiments. Electromotive force (EMF) of induction, Lenz's rule. Generators of electric current. Mechanisms of EMF induction initiation; vortex electric field.
53. The phenomenon of self-induction, inductance, long solenoid inductance. Concept of the mutual induction. Trasformers.
54. Magnetic field energy. Volume energy density of the magnetic field.
55. The displacement current. The relative nature of the electric and magnetic fields, electromagnetic field. Maxwell's equations in integral form as a complete system of classical electrodynamics equations.

Tests on theoretical material Laboratory workshop on electrodynamics Control tasks to laboratory work on electrodynamics II /7/.

№ п/п	Individual task №3 Problems 5-7	№ п/п	Individual task №3 Problems 5-7
1.	Option 1	**17**	Option 7
2.	Option 2	**18**	Option 8
3.	Option 3	**19**	Option 9
4.	Option 4	**20**	Option 10
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16	Option 6	**32**	Option 2

Oscillatory and wave processes

Theory

Oscillatory processes

56. Periodic processes in nature and technology. Spectral decomposition of an arbitrary periodic process. Harmonic oscillations as the simplest component of arbitrary periodic process. Natural (free) oscillations. The concept of a harmonic oscillator. The differential equation of a harmonic oscillator oscillations and its solution.

57. A spring, mathematical and physical pendulums. Electrical oscillating circuit in the absence of active resistance.

58. *The energy of the harmonic oscillation. Energy conversion during the oscillation process*.

59. Damping mechanical and electromagnetic oscillations. Attenuation coefficient, logarithmic decrement, Q-factor. Aperiodical processes.

60. The addition of harmonic oscillations of the same direction and the same frequencies. The beatings. The addition of mutually perpendicular oscillations with equal and different frequencies. Lissajous figures, their using for measurement of the frequency of the oscillations.

61. Forced oscillations, the differential equation of forced oscillations (mechanical and electromagnetic), its solution. The amplitude and the phase of the forced oscillations. Resonance, its application in the science and engineering. Resonant curves, their analysis.

Tests on theore tical material Laboratory workshop on oscillatory and wave processes. Control tasks to laboratory work on oscillatory and wave processes. I /7/.

№ п/п	Individual task №4 Problems 1–4	№ п/п	Individual task №4 Problems 1–4
1.	Option 1	**17**	Option 7
2.	Option 2	**18**	Option 8
3.	Option 3	**19**	Option 9
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Wave processes

62. The mechanism of mechanical waves formation in the elastic medium. Longitudinal and transverse waves. A travelling wave. Stationary, monochromatic, sine waves. The wave surface, wave front, the wavelength, the wave number, the wave vector, the phase velocity. Plane and spherical waves. Equation of a travelling wave, the wave equation.

63. *Wave propagation in media with dispersion. The concept of a wave packet and of a group velocity.*

64. The principle of superposition. Interference of monochromatic waves; coherence.

65. Standing waves. Nodes and antinodes. The eigenfrequencies of a bounded medium.

66. *Elements of acoustics. Characteristics of sound waves. Ultrasound and its using. Refraction and reflection of sound.*

67. Maxwell's equations in the absence of electrical charges and conductivity currents; electromagnetic waves, the speed of their propagation in dielectric. Differential equation of the electromagnetic wave. Energy of the electromagnetic wave. Pointing vector. Transmission and receivement of electromagnetic waves.

68. *The scale of electromagnetic waves, their basic properties. Using of electromagnetic waves of the different range*.

Tests on theoretical material Laboratory workshop on oscillatory and wave processes. Control tasks to laboratory work on oscillatory and wave processes. II /7/.

№ п/п	Individual task №4 Problems 5–7	№ п/п	Individual task №4 Problems 5–7
1.	Option 1	**17**	Option 7
2.	Option 2	**18**	Option 8
3.	Option 3	**19**	Option 9
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13	Option 3	**29**	Option 9
14	Option 4	**30**	Option 10
15	Option 5	**31**	Option 1
16	Option 6	**32**	Option 2

Literature

Principal

1. Кучерук І.М., Горбачук І.Т., Луцік П.П. Загальний курс фізики, — Київ. Техніка, 1999-2000, т.1,2
2. Курс фізики (під редакцією Лопатинського І.Є.). — Львів.: ”Бескід Біт”, 2002
3. Савельев И.В. Курс общей физики. - М.: Наука, 1977-1978, т.1,2
4. Савельев И.В. Курс физики. - М.: Наука, 1988-1989, т.1,2
5. Детлаф А.А. Курс физики. - М.: Высшая школа, 1989, 2001
6. Трофимова Т.И. Курс физики. - М.: Высшая школа, 1990, 1997, 2005.
7. Гаркуша І.П., Курінний В.П., Мостіпан Л.Ф. Фізика. - Дніпропетровськ: НГУ. 2008, 2011
8. Гаркуша І.П. Физика.Ч.1. Механика. Учебное пособие. Днепропетровск. ДВНЗ НГУ 2011
http://physics.nmu.org.ua/ua/personal/profesori/GarkushaIP/?par=3

Физика. Ч. 3.1. Электростатика. Постоянный ток. Учебное пособие для бакалавров отрасли знаний 0503 «Разработка полезных ископаемых».

Фізика Ч. 3.2. Електромагнетизм: Навчальний посібник для студентів вищих технічних навчальних закладів

Физика. Ч. 4. Колебания и волны. Учебное пособие:

9. Певзнер М.Ш. Основи теорії відносності. Навчальний посібник. ДВНЗ. 2013.
http://physics.nmu.org.ua/ua/personal/profesori/Pevzner/?par=3

Additional

10. Яворский Б.М., Пинский А.А. Основы физики - М. Наука, 1969, 1972, т.1,2.
11. Гаркуша І.П., Мокляк З.П., Буслов Ю.О. Фізика. Задачі з розв'язаннями. Дніпропетровськ. НГУ.2003.

Notation. Items typed by italic are supposed to be studied by yourselves.

Information resources

1. http://farside.ph.utexas.edu/teaching/301/lectures/lectures.html
2. https://wikis.mit.edu/confluence/display/RELATE/Accelerate%2C+Decelerate
3. http://farside.ph.utexas.edu/teaching/301/lectures/lectures.html.
4. http://www.damtp.cam.ac.uk/user/tong/relativity/dynrel.pdf