PROGRAM of the course "Physics"
for group EM -15-2
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

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 rigiid 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 relative to the axis. Angular momentum of a rigid relative 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 variable force. The work of elasticity, gravity and friction forces. Power.
18. Energy as a general motion and interaction measure. Mechanical energy. The concept of conservative forces and conservative system.
19. The kinetic energy of the particle and systems of the particles. The kinetic energy of a solid with a fixed rotation axis and of the plane motion.
20. 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.
21. *Applying the laws of energy and momentum conservation to elastic and inelastic collisions.*
22. The law of angular momentum conservation. The concept of the gyroscopic effect, its usage in the automatic systems.

Elements of the special relativity theory

23. The relativity principle in classical mechanics. Galilean transformations. Velocities addition law in Newtonian - Galilean mechanics. The conception of the Galilean invariants.
24. Einstein's postulates. Lorentz transformations.

25. Relativistic addition law of velocities. Relativity of length and time. The interval between events, its invariance.
26. Mass and momentum of the relativistic particle. Relativistic motion equations. Newtonian - Galilean mechanics as a limiting case of a relativistic mechanic one.
27. Kinetic energy, self-energy and total energy of the relativistic particle. The conception of the coupling energy of the relativistic system.

Molecular physics and thermodynamics

Elements of classical statistics

28. Statistical and thermodynamic methods of the macroscopic system description, the relationship between them. Thermodynamic equilibrium. The conception of the matter state equation.
29. The conception of the distribution function of the random variable. The distribution of an ideal gas molecules velocities in a thermodynamic equilibrium state. Velocities of an ideal gas molecules.
30. The average translational kinetic energy of an ideal gas molecules, its dependence on temperature. Molecular-kinetic interpretation of temperature in classical statistics.
31. Number of the molecule degrees of freedom. The law of equal energy distribution upon the molecules degrees of freedom and its limitation. Average kinetic energy of the polyatomic molecules.
32. Molecular-kinetic theory equation of an ideal gas for pressure and the consequences from it.
33. Boltzmann distribution and its application.
34. The molecules collision and free path of the molecules. The vacuum concept.

Fundamentals of Thermodynamics

35. The concept of reversible and irreversible processes. The process functions and state functions.
36. The internal energy of a thermodynamic system as its state function. The ideal gas internal energy.
37. Heat and ways of its transmission. Work performed by the thermodynamic system when changing its volume.
38. The first law of thermodynamics and its application to the ideal gas.
39. The classical theory of an ideal gas heating capacities and its limitations.
40. Adiabatic process. The adiabat equation of an ideal gas. The concept of the polytropic processes.
41. *Calculation of work and heat quantity that an ideal gas gets in different isoprocesses.*
42. *Thermodynamic cycles and its efficiency, Carnot cycle, ideal Carnot cycle and its efficiency, Carnot theorem. The heat and the refrigeration machines action.*
43. *The second law of thermodynamics. The conception of entropy. The second law of thermodynamics as the entropy increasing law. Irreversibility of the real processes in nature.*

Elements of physical kinetics. Transfer processes

44. *Transfer processes as irreversible processes. The phenomena of diffusion, thermal conductivity and internal friction. Fick, Fourier and Newton equations.*
45. *Kinetic theory of transfer phenomena. Transfer coefficients and their analysis.*

Aggregate states. Phase equilibrium and phase transitions

46. *Intermolecular interactions. Rejection properties of real gases from ideal ones. The state equation of real gas.*
47. *The critical state of matter. Saturated vapour and unsaturated one. Air humidity.*
48. *Structure and properties of fluids. Surface tension, wetting, capillarity.*
49. *Features of solids. Physical types of the crystal lattices. Defects in crystals and mechanical properties of solids.*
50. *Phases and phase transitions .The concept of the first and the second kind phase transitions. Clausius – Clapeyron equation.*

Tests on theoretical material

Laboratory workshop on physical principles of mechanics, molecular physics and thermodynamics.

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

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

Control tasks to laboratory work in molecular physics and thermodynamics /7/

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

Electrodynamics

Electrostatics

51. Electric charge, its discretion. Charge conservation law. Coulomb law.
52. 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.
53. Graphic representation of an electrostatic field. Electrostatic field strength lines. Flux of the electrostatic field strength lines.
54. Gauss theorem for the electrostatic field strength vector and its application.
55. The work performed by moving the charge in an electrostatic field; potential. The circulation of the electrostatic field strength vector. The electrostatic field potential character.
56. Equipotential surfaces. Connection of the field strength with potential.
57. The electrostatic field in dielectrics. Dielectrics polarization.
58. Ferroelectrics. Piezoelectric effect and its application.
59. Conductors in the electrostatic field. Electrostatic screening.
60. Conductor and capacitor electrocapacity.
61. Energy and volume energy density of the electrostatic field.

Constant electric current

62. Conditions of a constant electric current existence. Current strength and current density. Electric field of a constant current.
63. Exstraneous forces. Electromotive force and voltage.
64. Ohm's law in integral and differential forms. Kirchhoffs rules and their application.
65. Work and power of an electric current. Joule's law in integral and differential forms.
66. Electric current in gases, ionization and recombination. The concept of the plasma. Thermoelectronic emission; electrovacuum devices.

Stationary magnetic field

67. Field of moving charge. Magnetic field and its relativistic origin.
68. Effects of magnetic field on the conductor with current. Ampere's law. The magnetic field induction. .
69. Circuit with a current in the magnetic field. Magnetic moment of the circuit with a current. The electric motor action.
70. Lorentz force. Motion of charged particles in the magnetic field. Hall effect and its application.
71. 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.
72. Circulation of magnetic induction vector. Vortex nature of the magnetic field. The solenoid magnetic field.
73. The flux of a magnetic induction vector. Gauss theorem for a magnetic induction vector.
74. Work performing by moving the conductor and the circuit with a current in the magnetic field.

Magnetic field in matter

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

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

77. Faraday's experiments. Electromotive force (EMF) of induction, Lenz's rule. Generators of electric current. Mechanisms of EMF induction initiation; vortex electric field.
78. The phenomenon of self-induction, inductance, long solenoid inductance. Concept of the mutual induction. Trasformers.
79. Magnetic field energy. Volume energy density of the magnetic field.
80. 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 /7/.

№ п/п	Individual task №2	№ п/п	Individual task №2
1.	Variant 1	**17**	Variant 7
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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

Additional

8. Яворский Б.М., Пинский А.А. Основы физики - М. Наука, 1969, 1972, т.1,2.
9. Гаркуша І.П., Мокляк З.П., Буслов Ю.О. Фізика. Задачі з розв'язаннями. Дніпропетровськ. НГУ.2003.
10. Гаркуша І.П. Физика.Ч.1. Механика. Учебное пособие. Днепропетровск. ДВНЗ. НГУ. 2011
11. Гаркуша І.П.Физика.Ч.2. Молекулярная фізика и термодинамика. Учебное пособие. Днепропетровск. ДВНЗ. НГУ. 2012
12. Гаркуша І.П. Физика.Ч.3. Электростатика. Учебное пособие. Днепропетровск. ДВНЗ. НГУ. 2013.

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