Tribhuvan University
Institute of Science and Technology

Physics

Course Title: Mechanics, Thermodynamics, Statistical Physics, Electricity and Magnetism **Year :** I

Course Code: PHY101 **Full Marks:** 100
Nature of Course: Theory **Pass Marks:** 35
Duration: 150 hours

Course Objectives

At the end of this course the student should be able to acquire sufficient basic knowledge in physic and apply this knowledge for higher studies and research in physics

MECHANICS [50]

Course Contents:

1. **Review of Laws of Motion: 1.1** Dynamics of a particle, General equations of motion, Types of forces, Conservation laws, Work-Energy theorem, Conservative forces, 1.2 Motion of a body near the surface of the earth, Linear restoring force, Potential energy curve, Non-conservative forces. [3 hours]
2. **Linear and Angular Momentum: 2.1** Conservation of linear momentum, Centre of mass, Collision of two particles, 2.2 Deflection of a moving particle by a particle at rest, Rocket, Angular momentum and torque, 2.3 Motion under central force, Areal velocity, 2.4 Examples of conservation of angular momentum. [5 hours]
3. **Gravitational Potentials and Fields: 3.1** Central Forces, Inverse square-law of force, 3.2 Gravitational field and potential, Velocity of escape, 3.3 Potential and field due to a thin spherical shell and due to a solid sphere, Gravitational self energy, 3.4 Gauss's and Poisson's equation for gravitational field, 3.5 Kepler's laws of planetary motion, 3.6 Deduction of Newton's law of gravitation from Kepler's Laws. [7 hours]
4. **Dynamics of Rigid Bodies: 4.1** Equations of motion for a rotating rigid body, 4.2 Theorems on moment of inertia (M.I.), M.I. of a rectangular lamina, Solid uniform bar of rectangular cross-section, Circular disc, Solid cylinder, Solid sphere and spherical shell, 4.3 Kinetic energy of a rotating and rolling bodies, 4.4 Motion of a body rolling down an inclined plane, 4.5 Reduction of two body problem to a single body problem. [6 hours]
5. **Harmonic Oscillator: 5.1** Simple harmonic motion (S.H.M.) and harmonic oscillator, 5.2 Examples of harmonic oscillator, Simple pendulum, Compound pendulum, 5.3 Mass-spring system, 5.4 Torsional pendulum, 5.5 Helmholtz resonator, 5.6 Oscillation of two particles connected by a spring ,N-coupled oscillators, 5.7 Damping force, Damped and forced harmonic oscillator, 5.8 Power dissipation, Quality factor, 5.9 Power absorption. [8 hours]
6. **Wave Motion: 6.1** General equation of wave motion, 6.2 Equation of plane progressive harmonic wave, 6.3 Particle velocity and wave velocity, 6.4 Energy density for a plane progressive wave,

6.5 Intensity of wave and spherical waves, 6.6 Transverse waves in stretched strings, Modes of vibration, 6.7 Longitudinal waves in rods and gases, 6.8 Flow of energy in stationary waves. [7 hours]

7. **Elasticity: 7.1** Relations connecting various elastic constants, 7.2 Angle of twist and angle of shear, 7.3 Twisting couple on a cylindrical rod or wire, 7.4 Work done in twisting a rod or wire, 7.5 Bending of beams, Bending moment, 7.6 Cantilever, 7.7 Beam supported at its ends and loaded in the middle. [8 hours]
8. **Fluid Mechanics - Viscosity: 8.1** Kinematics of moving fluid, 8.2 Equation of continuity, 8.3 Bernoulli's theorem and its applications, 8.4 Viscous fluids, Streamline and turbulent flow, Critical velocity, 8.5 Reynold's number, 8.6 Poiseuille's equation, Capillaries in series and parallel. [6 hours]

THERMODYNAMICS [35]

Course Contents:

9. **Thermodynamic Fundamental Concepts: 9.1** Thermodynamic systems, Thermal and thermodynamic equilibrium, Equation of state, Thermodynamic processes, 9.2 External and internal work, Internal energy, Quasi-static, Isothermal, Adiabatic, Isobaric and isochoric processes. [3 hours]
10. **Laws of Thermodynamics and Their Application: 10.1** Zeroth law, First law of thermodynamics, Second law of thermodynamics, 10.2 Carnot's theorem, 10.3 Absolute scale of temperature, 10.4 Entropy changes in reversible and irreversible processes, Principle of increase of entropy, 10.5 Entropy and second law, 10.6 Third law of thermodynamics and its applications. [6 hours]
11. **Thermodynamic Relations**: 11.1 First and second latent heat equations, 11.2 Triple point, Thermodynamic potentials, 11.3 Helmholtz's function, Enthalpy, 11.4 Gibb's function, 11.5 Maxwell's thermodynamic relations, Phase transition, 11.6 Clausius-Clapeyron equation. [6 hours]
12. **Concept of Ideal and Real Gases: 12.1** Concept of ideal and real gases, 12.2 Joule expansion, Joule's law for perfect gas, 12.3 van der Waals equation, Critical constants of van der Waals gas, 12.4 Joule-Thomson expansion, Porous plug experiment, 12.5 Constancy of enthalpy, Adiabatic expansion. [5 hours]
13. **Production of Low Temperature: 13.1** Thermodynamics of refrigeration, Refrigeration cycle, Co-efficient of performance, 13.2 Cooling in Joule-Thomson expansion, Regenerative cooling, Cascade cooling, 13.3 Boyle's temperature of inversion, 13.4 Critical temperature and their relations, 13.5 Liquefaction of Helium and its properties. [4 hours]
14. **Transport Phenomenon: 14.1** Molecular collisions, Collision cross-section, Molecular diameter, Mean free path, 14.2 Transport phenomenon, Transport of momentum - viscosity, 14.3 Transport of energy - thermal conductivity, 14.4 Transport of mass - diffusion, 14.5 Brownian motion, Einstein's theory of Brownian motion. [5 hours]
15. **Black Body Radiation: 15.1** Total energy density, Spectral energy density, 15.2 Emissive power, Absorptive power, Kirchoff's law, 15.3 Pressure of radiation, Pressure of diffusive radiation, Stefan-Boltzmann's law , 15.4 Spectrum of black body radiation, Wien's displacement law, 15.5 Planck's radiation law, Rayleigh-Jean's law. [6 hours]

STATISTICAL PHYSICS [15]

Course Contents:

16. **Classical statistical physics: 16.1** Phase space, Microstate, Macrostate, 16.2 Ensemble, Constraints and accessible states, 16.3 Thermodynamic probability, 16.4 Fundamental postulates of statistical mechanics, 16.5 Division of phase space into cells, 16.5 Boltzmann's canonical distribution law, 16.6 Maxwell's distribution law of velocities, 16.7 Maxwell-Boltzmann statistics, 16.7 Law of equipartition of energy. [10 hours]
17. **Introduction to Quantum Statistical Physics: 17.1** Bose-Einstein statistics, 17.2 Fermi-Dirac statistics, 17.3 Black body radiation, 17.4 Electron gas in metals, 17.5 Fermi energy. [5 hours]

ELECTRICITY AND MAGNETISM [50]

Course Contents:

18. **Elementary Vector Analysis: 18.1** Gradient of a scalar, Divergence and curl of a vector in cartesian coordinates, 18.2 Divergence in polar coordinates, 18.3 Gauss's, Stoke's and Green's theorems, 18.4 Laplacian in polar co-ordinate system, 18,5 Laplace's and Poisson's equation. [5 hours]
19. **Electrostatic Potential and Field: 19.1** Coulomb's law, Electric Potential energy of a system of charges, Electric field strength, Electric flux, 19.2 Gauss's law and it's applications, 19.3 Electric potential and the line integral of the electric field, 19.4 Equipotential surface, Potential and field due to an electric dipole, Potential due to an infinitely long charged wire, Potential and field due to an uniformly charged disc, 19.5 Force on a surface charge, 19.6 Method of electrical images. [7 hours]
20. **Electric Fields in Dielectrics: 20.1** A dipole in an electric field, Polar and non-polar molecules, 20.2 Dielectric polarization, Electric field due to a polarized dielectric (three electric vectors), 20.3 Gauss's law in dielectric, Energy stored in an electric field in the presence of dielectric, Boundary conditions on field vectors, Molecular field in a dielectric, 20.4 The Clausius-Mossotti relation, Polar molecules, 20.5 The Langevin Debye formula. [6 hours]
21. **Magnetic Fields of Moving Charges: 21.1** Magnetic field and the magnetic flux, 21.2 Biot-Savart's law and its applications, 20.3 Lorentz force, Ampere's circuital law and its applications, Curl **B** and div **B,** 20.4 Magnetic vector and scalar potentials, 20.5 Magnetic dipole, 20.6 Force between current carrying parallel wires. [6 hours]
22. **Magnetic Properties and Fields: 22.1** The absence of isolated magnetic poles, 22.2 Magnetic dipole moment of current loop and angular momentum, Magnetization, 22.3 Langevin's theory of diamagnetism and paramagnetism, 22.4 Theory of ferromagnetism, 22.5 Energy loss due to hysteresis, 22.6 Magnetic susceptibility and permeability, Ferrites. [6 hours]
23. **Electromagnetic Inductions: 23.1** Faraday's law, Skin effect, 23.2 Moving coil ballistic galvanometer, Search coil, Flux meter, Earth inductor, Self and mutual induction, 23.3 Reciprocity theorem of mutual inductances, Self inductance of a solenoid, Toroid and two long parallel wires, 23.4 Energy stored in magnetic field, Transformer. [4 hours]

24. **Varying Currents: 24.1** Charging and discharging of a condenser through a resistance, 24.2 Rise and decay of current in LR & LC circuit, 24.3 Charging and discharging of a capacitor through inductance and resistance. [3 hours]
25. **Alternating Current Circuit: 25.1** The complex number method for AC analysis, Impedance, Reactance and admittance, 25.2 LCR circuits, Phase diagrams, Sharpness of resonance, 25.3 Quality factor, Power factor. [4 hours]
26. **Maxwell's Electromagnetic Equations: 26.1** The displacement current, Maxwell's equations and their use in propagation of electromagnetic wave, 26.2 Poynting vector, Derivation of Gauss's theorem, 26.3 Faraday's law, Lenz law, 26.3 Biot-Savrat's law and Ampere's circuital law, 26.4 Energy of a charged particle in an electromagnetic field, 26.5 Reflection and refraction of electromagnetic waves at the interface between two media, 26.6 Plane wave solution of Maxwell's equations, The wave equation, 26.7 Plane electromagnetic waves in isotropic dielectric and in conducting media. [9 hours]

Text Books:

1. *Mathur D. S. (Revised by P. S. Hemne)* – **Mechanics,** S. Chand and Company, Revised Ed. (2012)

2. *Singhal S. S., Agarwal J. P., Prakash S.* - **Heat, Thermodynamics and Statistical Physics**, Pragati Prakashan, Meerut, 21st Ed. (2009)

3. *Reitz J. R., Milford F. J., Christy R. W.* **- Foundations of Electromagnetic Theory**, Narosa Publishing House, New Delhi, 3rd Ed. (1998)

Reference Books:

1. *Upadhyaya J. C.* – **Mechanics,** Ram Prasad and Sons, Agra, 4th Ed (1994)

2. *Verma M. K.* **- Introduction to Mechanics,** University Press (India) Pvt. Ltd., 1st Ed. (2008)

3. *Sears F. W., Salinger G. L.* **- Thermodynamics, Kinetic Theory and Statistical Thermodynamics**, Narosa Publishing House, New Delhi, 3rd Ed. (1998)
4. *Lal Brij and Subrahmanyam N.* **- Heat and Thermodynamics**, S. Chand and Company, New Delhi, 16th Ed. (1994)

5. *Reif F.* - **Fundamentals of Statistical and Thermal Physics,** McGraw Hill, Delhi (1985)

6. *Kittel C., Kroemer H.* **- Thermal Physics,** CBS Publishers, New Delhi, 2nd Ed. (1987)

7. *Arora V. P., Saxena M. C., Prakash S.* **- Electricity and Magnetism**:, Pragati Prakashan, Meerut, 18th Ed. (2007)

8. *Laud B. B.*– **Electromagnetics,** Wiley Eastern Limited, 2nd Ed. (1992)

9. *Griffiths D. J.* **- Introduction to Electrodynamics**, PHI India, New Delhi, 3rd Ed. (2002)

Tribhuvan University

Institute of Science and Technology
Physics

Course Title: Physics Laboratory
Course Code: PHY102
Nature of Course: Practical

Year: I
Full Marks: 50
Pass Marks: 20
Duration: 180 hrs

Course Description:

Physics Laboratory (General) Practical course consists of three sections: (a) Mechanical Experiments, (b) Heat & Thermodynamics Experiments, and (c) Electricity & Magnetism Experiments. Students have to perform at least 15 experiments in 180 working hours. Students are required to perform 3 hours laboratory work twice in a week. Students should complete at least 20 experiments in the first year. Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet, and to keep them neat and properly filed.

Course Objectives:

1. To provide students with skill and knowledge in the experimental methods.
2. To make them able to apply knowledge to practical applications.
3. To make them capable of presenting their results/conclusions in a logical order.

B.Sc. First Year Lab Works [180]

1. To determine the value of acceleration due to gravity by using Bar Pendulum.
2. To determine the value of acceleration due to gravity by using Kater's pendulum.
3. Perform the experiment 1 and 2 and compile a dataset of acceleration due to gravity of your laboratory in a single set. Show the histogram and calculate the standard deviation and standard error. Interpret the result.
4. To determine the moment of inertia of a flywheel.
5. To determine the angular acceleration of a flywheel.
6. To determine the radius of gyration by of Bar Pendulum.
7. To determine the Young's modulus of the material by bending beam method.
8. To determine of modulus of rigidity of wire by Maxwell's vibration needle.

9. To study the conservation of momentum using Newton's Cradle.
10. To determine the surface tension of liquid by Jaeger's method.
11. To determine the coefficient of viscosity of water by Poiseulle's method.
12. To find the co-efficient of thermal conductivity of a bad conductor by Lee's method.
13. To find the co-efficient of thermal conductivity of insulating material (such as porcelain, wood, or Styrofoam) using Thermocouples and a Fluke 52 digital thermometer.
14. To determine the mechanical equivalent of heat by Callender and Barne's constant flow method.
15. To determine the sensitivity and constant of Ballistic galvanometer.
16. To determine the capacitance by Ballistic galvanometer.
17. To determine the high resistance by the method of leakage.
18. To determine the low resistance by Carey Foster bridge.
19. To determine the magnetic field using search coil.
20. To determine the impedance of LCR series circuit.
21. To determine the time constant for RL, RC and LCR circuit.
22. To determine the efficiency of an electric kettle (or heating element) under varying input voltages.
23. To determine the capacitance of a capacitor by ac bridge (de-Sauty's method).
24. To determine the inductance of an inductor by Maxwell inductance-capacitance bridge.
25. To determine the coefficient of mutual inductance of two coils.

Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010)
2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999)

Evaluation Scheme:

1. Student must perform three hours laboratory work twice a week to complete PHY102 lab works.
2. PHY102 will be examined for the duration of six hours in two different three hours sessions.
3. The practical exam will be graded on the basis of the following marking scheme:

Record file:	20%	Experiment:	50%
Error Analysis:	10%	Viva:	20%