Physics (Theory)

Total: 6 hours /week
Lecture: 4 hours/week
Tutorial: 0 hour/week
Practical: 0 hours/week
Lab: 2 hours/week

Course Description

This course in physics is designed to provide students with an understanding of the scientific laws of our physical world and how physics contributes to life's activities in modern society. The course emphasizes both quantitative and qualitative aspects of Physics, involving mathematical models and equations. The application of Physics to social and environmental situations is well illustrated.

The practical component of this course is designed to supplement learning through the application of learned theory. The students will handle simple apparatus to do simple measurements, demonstrate simple electrical circuits, and apply their knowledge of physics to real life examples.

Course objectives

After completion of this course the student will be able to:

- Correlate physics and its applications related to everyday experiences of their life.
- Identify the social, economic, environmental and other implications of physics.
- Describe physics as a coherent and developing framework of knowledge based on fundamental theories of the structures and processes of the physical world.
- Demonstrate the skills of experimenting, observing, interpreting data and evaluating evidence to formulate generalizations and models.
- Apply knowledge of physical principles to familiar and unfamiliar situations.
- Apply facts, vocabulary and conventions to unit measurements and common measuring instruments.
- Explain the definitions, laws, concepts, theories and models presented in this course.
- Describe the applications and implications of physical facts and principles.

Course Content

Unit 1: Mechanics **30hrs**

Sub-unit 1.1: Units and Measurement

- Physical concept of mass, length and time.
- Various systems of units and their conversion.
- Express derived units in terms of fundamental units.
- Precise and accurate measurement
- Dimensional formula for various physical quantities.
- Conversion of system of units using dimensions
- Simple numerical problems

Sub-unit 1.2: Scalar and Vectors

- Scalar and vectors quantities.
- Vector addition by parallelogram and triangle method.
- Resolve a vector into two components.
- The product of two vectors.
- Simple numerical problems

Sub-unit 1.3: Kinematics

- Displacement, velocity, instantaneous velocity, average and uniform velocity and acceleration (retardation).
- Distance and displacement, speed and velocity.
- The concept of projectile motion
- Simple numerical problems

Sub-unit 1.4: Force

- Newton's laws of motion.
- Interpret the meaning of inertia of rest and inertia of motion.
- Applications of inertia and impulse.
- Angular displacement, velocity and acceleration
- Relation between linear and angular velocity.
- Centripetal force and centrifugal force.
- Derivation of centripetal force.
- Friction, limiting friction, angle of friction and coefficient of friction.
- Laws of limiting friction.
- Relation between angle of friction and coefficient of friction.
- Simple numerical problems

Sub-unit 1.5: Work, Energy and power

- Work, energy and power.
- Conservation of energy for freely falling body.
- Transformation of energy
- Simple numerical problems

Sub-unit 1.6: Gravity and Gravitation

- Laws of gravitation.
- Acceleration due to gravity, mass and weight
- The relation between gravitation constant and acceleration due to gravity.
- The variation of g due to height and depth.
- Center of mass and center of gravity.
- Conditions of equilibrium.
- Simple numerical problems

Sub-unit: 1.7 Properties of Matter

- Hook's law
- Stress, strain and elasticity of solid material
- Elastic potential energy and energy density in a stretched wire (without derivation)
- The property of surface tension of liquid.
- Adhesive and cohesive forces.
- The capillary action.
- Viscosity and fluid movement
- Simple numerical problems

Sub-unit 1.8: Hydrostatics

- Fluid pressure
- Pascal's law.
- Density, relative density and specific gravity.
- Difference between density and specific gravity.
- Archimedes' principle
- The principle of floatation and condition of equilibrium for floating bodies.
- Atmospheric pressure
- The effect of air pressure on human body.
- Simple numerical problems

Unit 2: Heat **15hrs**

Sub-unit 2.1: Thermometry

- Concept of heat and temperature.
- Types of thermometers
- Relation between different temperature scales.
- Simple numerical problems

Sub-unit 2.2: Expansion

- Linear, superficial and cubical expansion of solids.
- Derivation of $\Upsilon = 3\prec$ and $\beta = 2\prec$.
- Apparent and real expansion of a liquid and its relation
- Change in density of an object due to change in temperature.
- Anomalous expansion of water.
- Simple numerical problems.

Sub-unit 2.3: Calorimetry

- Heat capacity and specific heat capacity.
- Relation between joule and calorie.
- Melting point, boiling point and freezing point of a substance.
- The effect of pressure on melting and boiling point of substance
- Determination of latent heat of fusion of ice and latent heat of steam by the method of mixture.
- Simple numerical problems

Sub-unit 2.4: Hygrometry

- Saturated and unsaturated vapours and their pressures.
- P-V and P-T diagrams and explain the behaviour of vapours.
- The effect of pressure and altitude on the boiling point of a liquid.
- Wet and dry bulb hygrometer and relative humidity.

Sub-unit 2.5: Transfer of heat

- The method of heat transfer by conduction, convection and radiation.
- Thermal conductivity.
- Black body and black body radiation.
- Stefan's law of black body radiation.
- Medical uses of heat radiation (thermal therapy)
- Simple numerical problems

Unit 3: Light **10hrs**

Sub-unit 3.1: Reflection of light

- Reflection and laws of reflection of light.
- Principle of rotation of mirror.
- Real and virtual image.
- Image formation of spherical mirror.
- Nature, size and position of the image formed by spherical mirrors.
- Simple numerical problems
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Sub-unit 3.2: Refraction

- Refraction and laws of refractions
- Refractive index
- Real depth and apparent depth.
- Lenses and lens formula
- Lens Maker's formula

Sub-unit 3.3: Optical Instrument

- Structure of human eye.

- Defects of vision and their correction.
- Use of simple and compound microscopes.
- Calculation of the magnifying power of simple and compound microscopes.
- Dispersion of light by prism.
- Simple numerical problems

Unit 4: Waves and Sound **10hrs**

Sub-unit 4.1: Waves

- Longitudinal and transverse wave.
- Equations of progressive and stationary waves
- Superposition of waves
- Reflection, refraction, diffraction, and interference of waves
- Simple numerical problems

Sub-unit 4.2: Characteristics of Sound Waves

- Velocity of sound in air (Newton's formula and Laplace's correction)
- Factors affecting velocity of sound.
- The characteristics of sound (note, pitch, intensity, loudness and timber)
- Overtones and quality of sound.
- Beat and beat frequency.
- Intensity level in terms of decibel.
- Threshold of hearing and threshold of pain.
- Ultrasonic wave and its medical uses.
- Simple numerical problems

Unit 5: Electrostatics **15hrs**

Sub-unit 5.1: Fundamentals of electrostatics

- Charges and their properties.
- Electrification by friction, conduction and induction on the basis of modern theory.
- Surface charge density
- Simple numerical problems

Sub-unit 5.2: Electrostatic Field

- Coulomb's law in electrostatics
- Dielectric constant (Permittivity) in a medium
- Electric field and normal electric flux
- Potential and potential energy (no derivation)
- Analogy between electric potential and gravitational potential.
- Concept about zero potential
- Capacitor and Capacitance
- Parallel Plate capacitor
- Series and Parallel grouping of capacitors
- Electron volt and its use
- Simple Numerical problems

Unit 6: Magnetism **15hrs**

Sub-unit 6.1: Fundamentals of Magnetism

- Geometrical and effective length, magnetic moment, Pole strength of magnet.
- Coulomb's law for magnetism.
- Magnetic field intensity due to bar magnet at end on position (b) broad side on position.
- Magnetic lines of force

- Neutral point
- Simple numerical problems

Sub-unit 6.2: Terrestrial Magnetism

- Dip, declination, horizontal and vertical components of earth's magnetic field.
- Properties of dia, para and ferromagnetic
- Domain theory of ferromagnetism.
- Simple numerical problems

Unit 7: Current Electricity **20hrs**

Sub-unit 7.1: Electric current

- Current as the rate of flow charge.
- Potential difference.
- Ohm's law and its verification.
- Resistance and resistivity
- Series and parallel combination of resistances
- Galvanometer and its conversion into ammeter and voltmeter.
- Ohmic and non-Ohmic conductors.
- Various types of electrical circuits.
- Simple numerical problems

Sub-unit 7.2: Resistance and heat

- Joule's laws of heating
- Heat production in resistance wire due to passage of current.
- Meaning of Joule's conversion factor.
- Emf, terminal potential difference, internal resistance and their relation.
- Electric power, watt, kilowatt, kilowatt-hour and horsepower.
- Simple numerical problems

Sub-unit 7.3: Chemical effect of current

- Faraday's laws of electrolysis.
- Faraday's constant and electrochemical equivalent.
- Thermoelectric effect and its verification, thermocouple
- Neutral point and temperature of inversion.
- Peltier effect.

Sub-unit 7.4: Alternating Current

- AC and DC.
- Relation between rms and mean value of current and voltage with its peak value. (Derivation not required)
- Merits and demerits of AC and DC.
- Introduction of a transformer and energy loss mechanisms in transformers.
- Faraday's law of electromagnetic induction.

Unit 8: Modern Physics **25hrs**

Sub-unit 8.1: Electron

- Particle nature of electricity.
- Production and properties of cathode rays.
- Motion of electron in electric and magnetic fields.
- Specific charge of an electron (introduction)
- Simple numerical problems

Sub-unit 8.2: Photoelectricity

- Photoelectric effect.
- Quantum theory of radiation.

- Einstein's photoelectric equation
- Stopping potential
- Photocells
- Simple numerical problems.

Sub-unit 8.3: X-ray

- Production, nature and use of x-rays.
- X-ray diffraction (Introduction)
- Simple numerical problems

Sub-unit 8.4: Radioactivity

- Radioactivity.
- Properties of α, β and γ radiations.
- Laws of radioactive disintegration and derivation of decay equation.
- Relation between half-life and decay constant.
- Radio-carbon dating
- Medical uses of radiation and artificial radioactive nuclei.
- Simple numerical problems.

Sub-unit 8.5: Properties of nucleus

- Nucleus and its properties.
- Isotopes, isotones
- Mass defect, binding energy and their relation.
- Binding energy curve
- Nuclear Fission and nuclear fusion reaction
- Einstein's mass energy relation
- Radiation hazards and safety.
- Biological effect of nuclear radiations
- Simple numerical problems

Sub-unit 8.6: Physics and Society

- Deteriorating conditions of the environment we live in.
- Useful and harmful aspects of radiation.
- Concepts about ozone depletion, greenhouse effect and acid rain.
- Environmental protection strategies

Reference Books

- Brij Lal and Subramanyan, Principles of Physics.
- Nelkon and Parker, Advanced Level Physics (5th ed.)
- Advance Physics, Surya Publication.
- Physics Practical Manual, Basanta Raj Rosyra (second edition)
- Pradhan, J.M. & Gupta, S.K., A Textbook of Physics (part I & II)
- Verma, H.C., Concepts of Physics I & II
- Sears, Zemansky & Young, University Physics
- Halliday, D & Resnick, R., Physics Part I & II
- Textbook of Physics Akshav Publication

Final written exam marking scheme

Unit	1	2	3	4	5	6	7	8	Total
Unit hours	30	15	10	10	15	15	20	25	140
Marks	16	9	6	6	9	9	11	14	80

Physics (Practical)

Practical: 70hrs

- Determine the volume of a hollow cylinder and a solid cylinder using vernier calipers.
- Determine the volume of a steel ball or glass rod using a micrometer screw gauge.
- Determine thickness of glass plate using spherometer.
- Determine the acceleration due to gravity by using simple pendulum.
- Demonstrate Archimedes' principle and find the specific gravity and density of solids heavier than water and insoluble in water
- Determine the specific gravity and density of substances lighter than water and insoluble in water
- Demonstrate the Verification the laws of reflection of light and find the relationship between object distance and image distance.
- Determine the refractive index of liquid/glass slab using travelling microscope.
- Draw ID curve through the prism and find the refractive index of prism.
- Determine the upper and lower fixed points of a given thermometer and find the correct temperature of tap water.
- Determine the focal length of a convex lens by the double pin method.
- Demonstrate the Verification the laws of moments of forces and find the weight of a given body.
- Determine the latent heat of fusion of ice by mixture method.
- Determine the melting point of wax by cooling curve method.
- Determine the magnetic moment and pole- strength of a bar magnet by locating the neutral points, keeping N-pole pointing south
- Determine the magnetic moment and pole- strength of a bar magnet by locating the neutral points, keeping N-pole pointing north.
- Determine unknown resistance of wire by using the concept of Ohm's law
- Demonstrate the variation of lateral displacement with an angle of incidence in a rectangular slab.
- Determine the refractive index of a prism using the I-D curve method.
- Determine velocity of sound in air at NTP using resonance tube apparatus
- Determine angle of dip in the laboratory
- Determine frequency of AC source using sonometer
- Demonstrate for Verification of the laws of rotation of light.