SEMESTER –IV

PHY04(T)

Special Theory of Relativity, Quantum Mechanics-I, Atomic Physics-I, Nuclear Physics-I, and Solid State Physics-I

(Lectures: 90)
(Full Marks: 75)

Unit I (10 Lectures)

Relativity: Galilean relativity and its failure. Galilean transformations. Michelson-Morley experiment. Basic postulates of special relativity. Lorentz transformation, length contraction, simultaneity, time dilation, velocity addition rule. Variation of mass with velocity, mass energy equivalence.

UNIT II (12 Lectures)

Failure of Classical physics, old quantum theory, wave nature of matter and de-Broglie relation. Statement and significance of Heisenberg uncertainty principle and illustration of this principle by a single-slit electron diffraction and Heisenberg's microscope. Application of uncertainty principle to prove the non-existence of electron in the nucleus and calculation of binding
energy of electron in hydrogen atom.

Concept of wave function and physical interpretation of the wave function. Normalization of a wave function with examples. Time-dependent and time-independent Schrodinger
equations, particle in a 1-D box

Unit III (18 Lectures)

Atomic structure: Methods of producing ionization in atoms. Excitation and ionization potentials. Mobility of ions, determination of e/m by Thomson's method, measurement of electric charge e by Millikan's oil-drop experiment. Measurement of mass of the electron, principle of cathode ray oscilloscope.

Positive ray analysis and mass-spectrographs: Thomson mass spectrograph, Bainbridge mass-spectrograph. Review of Bohr's theory of hydrogen atom and its spectral series. Introduction of quantum numbers with their significance, Pauli's exclusion principle, maximum number of electrons in an orbit.

X-rays: Principle of production of x-rays, hard and soft-x-ray, continuous spectrum and characteristic spectrum of x-rays, Moseley's law, Duane-Hunt law, Absorption of x-ray and exponential law, Compton scattering of x-rays and expression for wavelength change due to scattering.

Unit IV (30 Lectures)

Review of natural radioactivity, mean life, Basic ideas of α, β and γ decay. Interaction of γ rays with matter: photo electric effect, Compton scattering, pair production. Applications of radioactivity: radiography, radioactive tracers, radioactive dating.

Basic properties of a Nucleus-Composition, stability, charge, size, mass, binding energy and its calculation. Nuclear Reaction: Discovery of neutron, properties of neutron, Artificial transmutation (neutron and alpha particle induced transmutation), nuclear reaction energy, endothermic and exothermic processes.

Nuclear fission: Discovery, energy released in fission, chain reaction, secondary neutrons and their importance, multiplication factor (elementary idea), concept of critical size, nuclear reactor, types of reactors.

Nuclear fusion: Origin of stellar energy, calculation of fusion energy.

Cosmic rays and elementary particles: General characteristics, hard and soft component of cosmic rays, primary and secondary cosmic rays, altitude effect, Effect of Earth's magnetic field on cosmic ray: latitude effect and east-west effect, extensive air showers, origin of cosmic rays.

Classification of elementary particles and their properties.

Unit V (20 Lectures)

Crystal structure: Lattice translation vectors, crystal structure with basis and Bravais lattice, primitive cell and unit cell. Symmetry in crystals: viz translational, rotational, inversion symmetry and crystal types in 2- and 3-dimensions allowed by symmetry; sc, bcc, and fcc crystals and their coordination numbers and nearest neighbour distances. Closed-packed crystals and packing fraction of sc, bcc, and fcc lattices, Miller indices and inter planar spacing.

Free electron theory of solids: Classical treatment and Drude's theory of electrical conductivity, relation between electrical and thermal conductivity, inadequacy of free electron model. Qualitative explanation of energy band and band gap, distinction between conductors, semiconductors and insulators in terms of band gap.

Superconductivity: Discovery of superconductivity in Hg by Kamerlingh Onnes, persistent current, behaviour of a superconductor in a magnetic field, Meissner effect, destruction of super-conductivity by a magnetic field, critical fields, type-I and type-II superconductors.

Text Books:

1. **Introduction to Special Relativity**: Robert Resnick, Wiley, New Delhi, 2014.
2. **Atomic and Nuclear Physics:** A.B. Gupta And Dipak Ghosh, Book and Allied (P) Ltd, Kolkata, Latest edition.
3. **Quantum Mechanics:** G. Arun Das, Latest edition.
4. **Quantum Mechanics:** A.K. Ghatak and S. Lokanathan, Mac Muller, Latest edition.
5. **Fundamentals of Solid State Physics**: Saxena, Gupta and Saxena, Pragati Prakashan, Meerut, 17th Edition, 1999.

Reference Books:

1. **Modern Physics** : R .Murugeshan, Kiruthiga Sivaprasath, S. Chand and Co., New Delhi, Latest edition.
2. **Modern Physics**: G Aruldhas and P. Rajagopal, Prentice Hall India Private Limited, New Delhi, 2008.
3. **Undergraduate Physics Vol-II:** AB Bhattacharya and R Bhattacharya, New Central Book Agency, Kolkata, Reprint, 2008.
4. **Solid State Physics**: S.O. Pillai, New Age International Publishers, New Delhi, Sixth Edition, 2005.
5. **Quantum Physics:** Stephen Gasiorowicz, Wiley-India, New Delhi, 3rd Edition, 2009.

SEMESTER –IV

PHY04(P)

Experimental Physics-III

(Minimum eight experiments to be performed)

(Full Marks : 25)

List of experiments

1. Determination of the energy gap of a semiconductor diode.
2. To draw the characteristics of a LDR
3. To draw the characteristics of a photo-diode.
4. Measurement of current in an external circuit by using Potentiometer.
5. Use of a multimeter to measure the output voltages of half wave and full wave rectifiers and find the value of ripple factors.
6. Determination of Planck's constant by photocell or by heating method.
7. Determination of the specific charge (e/m) of an electron by magnetron/Thomson's method.
8. Determination of the value of an unknown low resistance by using potentiometer.
9. Determination of the emf of a battery by using potentiometer.
10. Verification of Thevenin's theorem.
11. Verification of Norton's theorem.
12. Verification of Superposition theorem.

Text Books

1. **B.Sc. Practical Physics**, C.L. Arora, S Chand and Co., 2005.
2. **A Text Book of Practical Physics**, S. Ghosh, New Central Book Agency, Kolkata, 2004.
3. **A Text Book on Practical Physics**, K.G. Mazumdar, Syndicate Press, 2006.