UGC MODEL CURRICULUM
PHYSICS, B.Sc. THIRD YEAR

COURSE 7: RELATIVITY QUANTUM MECHANICS, ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

7.1 RELATIVITY 15

Reference systems, inertial frames, Galilean invariance and conservation laws, propagation of light, Michelson-Morley experiment; search for ether. (5)

Postulates for the special theory of relativity, Lorentz transformations, length contraction, time dilation, velocity addition theorem, variation of mass with velocity, mass-energy equivalence, particle with a zero rest mass. (10)

7.2 QUANTUM MECHANICS 30

Origin of the quantum theory : Failure of classical physics to explain the phenomena such as black-body spectrum, photoelectric effect, Ritz combination principle in spectra, stability of an atom. Plank's radiation law, Einstein's explanation of photoelectric effect, Bohr's quantization of angular momentum and its applications to hydrogen atom, limitations of Bohr's theory. (5)

Wave-particle duality and uncertainty principle: de Broglie's hypothesis for matter waves; the concept of wave and group velocities, evidence for diffraction and interference of 'particles', experimental demonstration of matter waves. (4)

Consequence of de Broglie's concepts; quantisation in hydrogen atom; energies of a particle in a box, wave packets, Heisenberg's uncertainty relation of p and x, its extension to energy and time. (3)

Consequence of the uncertainty relation: gamma ray microscope, diffraction at a slit, particle in a box, position of electron in a Bohr orbit. (3)

Quantum Mechanics: Schrodinger's equation. Postulatory basis of quantum mechanics; operators, expectation values, transition probabilities, applications to particle in a one- and three-dimensional boxes, harmonic oscillator, reflection at a step potential, transmission across a potential barrier. (7)

Hydrogen atom; natural occurrence of n, l and m quantum numbers, the related physical quantities, comparison with Bohr's theory. (4)

7.3 ATOMIC PHYSICS 15

Spectra of hydrogen, deuteron and alkali atoms spectral terms, doublet fine structure, screening constants for alkali spectra for s, p, d, and f states, selection rules. (6)

Singlet and triplet fine structure in alkaline earth spectra, L-S and J-J couplings. (3)

Week spectra: continuous X-ray spectrum and its dependence on voltage, Duane and Hunt's law. Characteristics X-rays. Moseley's law, doublet structure of X-ray spectra, X-ray absorption spectra. (3)

7.4 MOLECULAR PHYSICS 15

Discrete set of electronic energies of molecules, quantisation of vibrational and rotational energies, determination of internuclear distance, pure rotational and rotation vibration spectra. Dissociation limit for the ground and other electronic states, transition rules for pure vibration and electronic vibration spectra. (7)

Raman effect, Stokes and anti-Stokes lines, complimentary character of Raman and infrared spectra, experimental arrangements for Raman spectroscopy. (3)

Spectroscopic techniques: Sources of excitation, prism and grating spectrographs for visible, UV and IR, absorption spectroscopy, double beam instruments, different recording systems. (5)

7.5 NUCLEAR PHYSICS 15

Interaction of charged particles and neutrons with matter, working of nuclear detectors, G-M counter, proportional counter and scintillation counter, cloud cambers spark chamber, emulsions. (7)

Structure of nuclei, basic properties (I μ, Q and binding energy), deuteron binding energy, p-p and n-p scattering and general concepts of nuclear forces. Beta decay, range of alpha particle. Geiger-Nuttal law. Gamow's explanation of beta decay, alpha decay and continuous and discrete spectra. (5)

Nuclear reactions, channels, compound nucleus, direct reaction (concepts). (3)

Shell model; liquid drop model, fission and fusion (concepts), energy production in stars by p-p and carbon cycles (concepts). (2)

COURSE 8: SOLID STATE PHYSICS, SOLID STATE DEVICES AND ELECTRONICS

8.1 SOLID STATE PHYSICS 30

Overview : Crystalline and glassy forms, liquid crystals, glass transition. (2)

Structure : Crystal structure; periodicity, lattices and bases, fundamental translation vectors, unit cell, Wigner-Seitz cell, allowed rotations, lattice types, lattice planes, common crystal structures. (5)

Laue's theory of X-ray diffraction, Bragg's law, Laue patterns. (2)

Bonding : Potential between a pair of atoms; Lennard-Jones potential, concept of cohesive energy, covalent, Van der Walls, ionic and metallic crystals. (3)

Magnetism : Atomic magnetic moment, magnetic susceptibility, Dia- Para-, and Ferromagnetics, ferromagnetic domains, Hysteresis. (3)

Thermal properties: Lattice vibrations, simple harmonic oscillator, second order expansion of Lennard-Jones potential about the minimum, vibrations of one dimensional monatomic chain under harmonic and nearest neighbour interaction approximation, concept of phonons, density of modes (1-D). Debye model; lattice specific heat, low temperature limit, extension (conceptual to 3-D). (8)

Band structure: Electrons in periodic potential; nearly free electron model (qualitative), energy bands, energy gap, metals, insulators, semiconductors. (3)

Motion of electron: Free electrons, conduction electrons, electron collisions, mean free path, conductivity and Ohm's law. Density of states, Fermi energy Fermi velocity, Fermi-Dirac distribution. (4)

8.2 SOLID STATE DEVICES 15

Semiconductors : Instrinsic semiconductors, electrons and holes, Fermi level.

Temperature dependence of electron and hole concentrations. Doping; impurity states, n and p type semiconductors, conductivity, mobility, Hall effect, Hall coefficient. (7)

Semiconductors devices: Metal-semiconductor junction, p-n junction, majority and minority carriers, diode, Zener and tunnel diodes, light emitting diode, transistor, solar cell. (8)

8.3 ELECTRONICS 45

Power supply : Diode as a circuit element, load line concept, rectification, ripple factor, zener diode, voltage stabilization, IC voltage regulation, characteristics of a transistor in CB, CE and CC mode, graphical analysis of the CE configuration, low frequency equivalent circuits, h-parameters, bias stability, thermal runaway. (15)

Field effect transistors: JFET volt-ampere curves, biasing JEET, ac operation of JFET, source follower, Depletion and enhancement mode, MOSFET, biasing MOSFET, FET as variable voltage resister, digital MOSFET circuits. (15)

Small signal amplifiers: General principles of operation, classification, distortion, RC coupled amplifier, gain frequency response, input and output impedance, multistage amplifiers, transformer coupled amplifiers, Equivalent circuits at low, medium and high frequencies; emitter follower, low frequency common-source and common-drain amplifier, Noise in electronic circuits. (15)