(10)

Physics

(1) Mathemetical Physics

Vector algebra and vector calculus, Matrices, Hermitian and skew Hermitian matrices, Eigen value and eigen vector, linear differential equation of first and second order, Fourier Series, Fourier and Laplace transforms. Elementary probability theory, random variables.

(2) Classical Mechanics

Generalised co-ordinates, D-Alembert Principle and Langrange's equation of motion, Derivation of Langrange's equation from Hamilton's principle, Types of oscillation's, small oscillation's using generalized co-ordinates, normal modes and normal co-ordinates, coupled pendulum , constraints & their classification.

(3) Quantum Mechanics

Fundamental concepts: Heisenberg Uncertainty principle, wave function, Schrödinger equation (time dependent and time independent) Eigen value problem (particle in a box, harnonic oscillator etc.) Commutators and operators, Dirac notation for state vectors, Hydrogen atcm, Stern Gerlach experiment, Time dependent perturbation theory and Fermi golden rule, Selection rules, Pauli exclusion principle, Spin angular momentum operators and their algebra, eigen values and eigen functions of L^2 and L_z operators, Schwartz inequality.

(4) Electromagnetic Theory

Clausius-Mossotti equation, Evaluation of molecular polarizability for simple models, Debye equation and temperature dependence of dielectric constant. Maxwell equations, Microscopic and Macroscopic fields, Dielectric tensor. Scalar and vector potentials Gauge Transformation, (Lorentz and Transverse) Maxwell equations in terms of electromagnetic potentials, Plane wave in an anisotropic

medium, Fresnel's Formula for propagation of light in crystals , Reflection and refraction of electromagnetic waves from a plane interface between two dielectric, Polarisation by reflection, Total internal reflection .

(5) Thermodynamics and Statistical physics

Law of thermodynamics and their consequences, Thermodynamic potentials, Chemical potentials, Phase equilibria, Micro canonical and grand canonical ensembles and partition function. Free energy and its connection with thermodynamical quantities, Ideal Bose and Fermi gases, Blackbody radiation and Planck's distribution law.

(6) Electronics

Semiconductor devices (junction diodes, transistors, field effect devices, homo and hetrojunction devices) structure, devices characteristics, Frequency dependence and applications. Optoelectronic devices (Solar cells, photo detectors LED's.), Boolean Algebra, Microprocessor and Microcontroller basics, Memories , C-MOS, ROM, MOS, RAM, D/A and A/D converters.

(7) Atomic and Molecular Physics:

Quantum states of an electron in an atom. Electron spin, Spectrum of helium and alkali atom. Hyperfine structure and isotopic shift, width of spectrum lines, LS & J J couplings. Zeeman and Paschen-Back & Stark effects, Electron spin resonance, Nuclear magnetic resonance, chemical shift, Born-Oppenheimer approximation, Electronic, Rotational, Vibrational and Raman spectra of diatomic molecules, selection rules.

Laser: Spontaneous and stimulated emission, Einstein A and B Coefficients, optical pumping, population inversion, rate equation, modes of resonance and coherence length.

(8) Nuclear and Particle physics

Basic nuclear properties: Size, shape and distribution, Spin and parity. Binding energy, semi empirical mass formula, liquid drop model ,

Nature of the nuclear force, Evidence of shell structure, Single particle shell model, its validity and limitation, Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and Fusion Nuclear reactions, Reaction mechanism, Compound nuclear and direct reactions.

Classification and important properties of elementary particles, Application of symmetry arguments to particle reactions, Parity –non-Conservation in weak interaction, Relativistic kinematics.

(9) Solid State Physics

Bravois lattices, Reciprocal lattice, Diffraction and the structure factor. Bonding in solids, Elastic properties, Phonons, specific heat, Free electron theory and electronic specific heat, Drude model for etectrical and thermal conductivity, Hall effect and thermoelectric power, Electron motion in a periodic potential, Origin of energy gap, Classical theory of Dia, para and ferromagnetism, Ferromagnetic Wiess theory, Curie point, Anti ferromagnetic Neel temperature, Anti ferromagnetic magnons.

(10) Topic of Special Interest

Superconductivity: Type-I and Type-II superconductors, Mesisner effect, Josephson junctions , Superfludity. Fullerens: Synthesis of C_{60}, and its properties, various forms of fulleren materials,

Physics of low dimension, nano Scale, Quantum Confinement(quantum well ,quantum wire, quantum dot.), Graphene, Carbon Nanotubes (Single walled and multi walled) applications.