HPCET Syllabus For Syllabus of M.Sc. Physics

APPENDIX-D

Syllabus of M.Sc. Physics

Section-A

Mathematical methods

Infinite sequences and series- convergence and divergence, conditional and absolute convergence, ration test for convergence. Calculus of single and multiple variable, partial derivatives, Jacobian, Imperfect and perfect differentials. Taylor Expansion, Vector algebra, Vector Calculus, Multiple integrals, Divergence theorem, Green's theorems, Stokes' theorem, Orthogonal coordinate systems. First order equations and linear second order differential equations with constant coefficients. Linear vector spaces, linear independence, basis. Matrices and determinants, Hermitian adjoint and inverse of a matrix; Hermitian, orthogonal and unitary matrices; Eigenvalue and eigenvectors. Fourier expansion- statement of Dirichlet's condition, analysis of simple waveforms and Fourier series. Probability distributions and error analysis.

Classical mechanics and general properties of matter

Newton's laws of motion and applications, Velocity and acceleration in Cartesian, Polar and cylindrical coordinate systems. Uniformly rotating frame, Centrifugal and Coriolis forces, System of particles. Center of mass, Equation of motion of the CM, Conservation of linear and angular momentum, Conservation of energy, Variable mass systems Motion under a central force, Kepler's laws Gravitational Law and field, Conservative and nonconservative forces Elastic and inelastic collisions. Differential equation for simple harmonic oscillator and its general solution, Superposition of two or more simple harmonic oscillators, Lissajous figures, Damped and forced oscillators, resonance, Wave equation, travelling and standing waves in one dimension, Energy density and energy transmission in waves, Group velocity and phase velocity, Sound waves in media, Doppler Effect. Rigid body motion, Euler angles, Fixed axis rotations. Moments of Inertia and products of Inertia, Parallel and perpendicular axes theorem, Principal moments and axes. Kinematics of moving fluids, Equation of continuity, Euler's equation, Bernulli's theorem.

Section-B

Optics

Fermat's principle, General theory of image formation, Thick lens, Thin Lens and lens combinations. Huygen's Principle, Interference of light, Optical path retardation, interferometers. Fraunhofer diffraction, Rayleigh criterion and resolving power, Diffraction gratings. Linear, Circular and elliptic polarization, Double refraction and optical rotation. Lasers, principle and working.

Electricity and magnetism

Electricity and Magnetism: Coulomb's law, Gauss's law, Electric field and potential Electrostatic boundary conditions, Solution of Laplace's equation for sample cases. Conductors, Capacitors, Dielectrics, Dielectric polarization Volume and surface charges, energy stored in Electromagnetic field Biot-Savart law, Ampere's law, Faraday's law of electromagnetic induction, Self and mutual inductance. Alternating currents, Simple DC and AC circuits with R, L and C components. Displacement current, Maxwell's equations and plane electromagnetic waves, poynting's theorem. Lorentz Force and motion of charged particles in electric and magnetic fields. Reflection and refraction at a dielectric interface, Transmission and reflection coefficients.

Section-C

Modern Physics

Inertial frames and Galilean invariance, Postulates of special relativity, Lorentz transformations, length contraction, Time dilation, Relativistic velocity addition theorem, Mass energy equivalence. Blackbody radiation, Planck's law, Rayleigh-Jeans and Wein's Law, Photoelectric effect, Compton Effect. Bohr's atomic model, Sommerfeld's correction, X-rays. Wave-particle duality, Uncertainty principle. Wave function and it's interpretation, wave packets, Dynamical variables as operators, measurement of observables, expectation values. Commutation relations between operators and compatibility, observables and simultaneous measurements, Ehrefest's theorem. Schrodinger equation and its solution for one, two and three dimensional boxes, Solution of Schrodinger equation for the one dimensional harmonic oscillator, Reflection and transmission at a step potential.

Nuclear and Particle Physics

General properties of Nuclei, Nuclear Models: liquid drop model, condition of nuclear stability. Experimental evidence for nuclear magic numbers, elementary accounts of nuclear shell model and its predictions, Radioactivity, qualitative account of the theory of alpha decay and beta decay, Interaction of Nuclear Radiation with matter; Energy loss due to ionization energy loss of electrons, Cerenkov radiation, Rutherford scattering, Multiple coulomb scattering, passage of gamma-rays through matter. Compton scattering, pair production radiation loss by fast electrons, Radiation length and electrongamma showers, position a annihilation, Relativistic Kinematics. Particles Accelerators and Detectors, classification of elementary particles, Types of interactions and its features, Mass spectra and major decays of elementary particle; leptons, mesons, baryons, Weak and electromagnetic Decays of Strange mesons and Hyperons. Classification of weak decays and selection rules.

Section-D

Atomic and Molecular Physics

Spectroscopy Good quantum numbers and selection rules. Stern-Gerlach experiment, Fine structure, Magnetic moment of the electron, Lande g factor, Vector model-Space quantization. Zeeman effect. Explanation from vector atom model. Pauli exclusion principle, shell structure. Hund's rule, spectroscopic terms of many electron atoms in the ground state, Spectra of alkali and alkaline earth atoms. Rotational and vibrational spectra, Raman effect, Stokes and anti-stokes lines, complimentary character of Raman and Infrared spectra, experimental arrangements for Raman spectroscopy.

Kinetic Theory of Gases and Thermodynamics

Elements of Kinetic theory of gases. Velocity distribution and Equipartition of energy. Specific hear of Mono-, di-and tri-atomic gases. Ideal gas, van-der-Waals gas and equation of state. Mean free path. Laws of thermodynamics. Zeroth law and concept of thermal equilibrium. First law and its consequences. Isothermal and adiabatic processes. Reversible, irreversible and quasi-static processes. Second law and entropy. Carnot cycle. Maxwell's thermodynamic relations and simple applications. Ideas of ensembles, Maxwell-Baltzmann, Fermi-Dirac and Bose-Einstein distributions.

Solid State Physics and Electronics

Basics of Crystal Structure: Lattice and basis, primitive and unit cell, Wigner Seitz cell, symmetry operations, lattice types, paeking fraction, Miller indices, simple structures NaCL, diamond. Diffraction Methods: Bragg's Law, experimental arrangements. Laue equation, reciprocal lattice, atomic scattering factor, geometrical structure factors. Crystal bonding: potential between a pair of atoms, LennardJones potential, Ionic, Covalent, Vander- Wall's cohesive energy, Lattice Vibration, specific heat Einstein and Debye's models of specific heat. Free electron theory of metals, Band Theory of Metals: Kronig Penny model, Brillouin zones, electrons in

periodic structure, energy bands, energy gaps, effective mass of electrons and holes, metals, insulators, semiconductors, Magnetism, Curie-Weiss law, Langevin theory, basics of superconductivity. Junction Diodes, Transistors their characteristics and simple circuit design: Thevnim's Theorem, Norton Theorem, Constant Voltage and current generator, idea of equivalent circuits, low frequency equivalent circuits, low frequency equivalent circuits, h-parameters, bias stability, thermal runaway, BIJ, FET' s and MOSFETS: Structure and working FET amplifier. Oscillators: Tuned Collector, Hartley and Colpitts oscillators, phase shift oscillators. Operational Amplifier, Inverting noninverting amplifier, OP-Amp as adder subtractor, comparator, integrator and differentiator. Modulation and detection, Digital electronic fundamentals, various number systems, Basic logic gates, de-Morgan's law.