Syllabus for the Entrance Examination for ~~Centralized~~ admissions in ~~Physics~~ M.Sc (Physics).

MECHANICS (7 Marks)

Mechanics of single and system of particles, conservation of laws of linear momentum,angular momentum and mechanical energy, Centre of mass and equation of motion,constrained motion, degrees of freedom.Generalised coordinates, displacement, velocity, acceleration, momentum, force andpotential. Hamilton's variational principle , Lagrange's equation of motion from Hamilton's Principle. Linear Harmonic oscillator, simple pendulum, Atwood's machine.

Rotation of Rigid body, moment of inertia, torque, angular momentum, kinetic energy ofrotation. Theorems of perpendicular and parallel axes with proof. Moment of inertia ofsolid sphere, hollow sphere, spherical shell, solid cylinder, hollow cylinder and solid barof rectangular cross-section. Acceleration of a body rolling down on an inclined plane.

ELECTRICITY AND MAGNETISM (7 Marks)

Mathematical Background : Scalars and Vectors, dot and cross product, Triple vectorproduct, Scalar and Vector fields, Differentiation of a vector, Gradient of a scalar and itsphysical significance, Integration of a vector (line, surface and volume integral and theirphysical significance), Gauss's divergence theorem and Stocks theorem.

Electrostatic Field : Derivation of field E from potential as gradient, derivation ofLaplace and Poisson equations. Electric flux, Gauss's Law and its application tospherical shell, uniformly charged infinite plane and uniformity charged straight wire,mechanical force of charged surface, Energy per unit volume.

Magnetostatistics : Magnetic Induction, magnetic flux, solenoidal nature of Vector field of induction. Properties of B (i) $\nabla.B = 0$ (ii) $\nabla xB = \mu_o J$. Electronic theory of dia and para magnetism (Langevin's theory). Domain theory of ferromagnetism. Cycle ofMagnetisation - Hysteresis (Energy dissipation, Hysteresis loss and importance ofHysteresis curve).

Electromagnetic Theory : Maxwell equation and their derivations, DisplacementCurrent. Vector and scalar potentials, boundary conditions at interface between twodifferent media, Propagation of electromagnetic wave (Basic idea, no derivation).Poynting vector and Poynting theorem.

PROPERTIES OF MATTER, KINETIC THEORY AND RELATIVITY (8 Marks)

Properties of Matter (Elasticity) : Elasticity, Hooke's law, Elastic constants and theirrelations, Poisson's ratio, torsion of cylinder and twisting couple. Bending of beam(bending moment and its magnitude) cantilevers, Centrally loaded beam.

Kinetic Theory of Gases : Assumptions of Kinetic Theory of gases, Law of equipartitionof energy and its applications for specific heats of gases. Maxwell distribution of speeds and velocities (derivation required), Experiomental verification of Maxwell's Law of speeddistribution : most probable speed, average and r.m.s. speed, mean free path.Transport of energy and momentum, diffusion of gases. Brownian motion (qualitative),Real gases, Van der Waal's equation.

Theory of Relativity : Reference systems, inertial frames, Gallilean invariance andConservation laws, Newtonian relativity principle, Michelson - Morley experiment :Search for ether. Lorentz transformations length contraction, time dilation, velocityaddition theorem, variation of mass with velocity and mass energy equivalence.

ELECTRO MAGNETIC INDUCTION AND ELECTRONIC DEVICES (8 Marks)

Electromagnetic Induction : Growth and decay of current in a circuit with (a) Capacitanceand resistance (b) resistance and inductance (c) Capacitance and inductance (d) Capacitanceresistance and inductance.AC circuit analysis using complex variables with (a) capacitance and resistance, (b) resistance and inductance (c) capacitance and inductance (d) capacitance, inductance and resistance Series and parallel resonant circuit. Quality factor (Sharpness of resonance).

Semiconductor Diodes : Energy bands in solids. Intrinsic and extrinsic semiconductor, Halleffect, P-N junction diode and their V-I characteristics. Zener and avalanche breakdown.
Resistance of a diode, Light Emitting diodes (LED). Photo conduction in semiconductors,photodiode, Solar Cell.

Diode Rectifiers : P-N junction half wave and full wave rectifier. Types of filter circuits (Land - with theory). Zener diode as voltage regulator, simple regulated power supply.

Transistors : Junction Transistors, Bipolar transistors, working of NPN and PNP transistors, Transistor connections (C-B, C-E, C-C mode), constants of transistor. Transistor characteristic curves (excluding h parameter analysis), advantage of C-B configuration. C.R. O. (Principle, construction and working in detail).
Transistor Amplifers : Transistor biasing, methods of Transistor biasing and stabilization. D.C. load line. Common-base and common-emitter transistor biasing. Common-base, common- emitteer amplifers. Classification of amplifers. Resistance-capacitance (R-C) coupled amplifer (two stage; concept of band width, no derivation). Feed-back in amplifers, advantage of negative feedback Emitter follower.
Oscillators : Oscillators, Principle of Oscillation, Classification of Oscillator. Condition for self sustained oscillation : Barkhousen Criterion for oscillations. Tuned collector common emitter oscillator. Hartley oscillator. Colpitt's oscillator.

COMPUTER PROGRAMMING & THERMODYNAMICS (7 Marks)

Computer Programming : Computer organisation, Binary representation, Algorithm development, flow charts and their interpretation. Fortran Preliminaries; Integer and floating point arithmetic expression, built in functions executable and non-executable statements, input and output statements, Formats, I.F. DO and GO TO statements, Dimesion arrays statement function and function subprogram.

Thermodynamics-I : Second law of thermodynamics, Carnot theorem, Absolutescale of temperature, Absolute Zero, Entropy, show that dQ/T=O, T-S diagramNernst heat law, Joule's free expansion, Joule Thomson (Porous plug)experiment. Joule - Thomson effect. Liquefication of gases. Air pollution due tointernal combustion Engine.

Thermodynamics-II : Derivation of Clausius - Claperyron latent heat equation.Phase diagram and triple point of a substance. Development of Maxwellthermodynamical relations. Application of Maxwell relations in the derivation ofrelations between entropy, specific heats and thermodynamic variables.
Thermodynamic functions : Internal energy (U), Helmholtz function (F), Enthalpy(H), Gibbs function (G) and the relations between them.

Optics – I (7 Marks)

Fourier Analysis and Fourier Transforms : Speed of transverse waves on auniform string. Speed of longitudinal waves in a fluid, superposition of waves(physical idea), Fourier Analysis of complex waves and its application for thesolution of triangular and rectangular waves, half and full wave rectifier out puts.Fourier transforms and its properties. Application of fourier transform to followingfunction.

(I) $f(x) = e^{-x^2/2}$

(II) $f(x) = 1 \quad [x] < a$

$= 0 \quad [x] > a$

Geometrical Optics : Matrix methods in paraxial optics, effects of translation andrefraction, derivation of thin lens and thick lens formulae, unit plane, nodalplanes, system of thin lenses, Chromatic, spherical coma, astigmatism anddistortion aberrations and their remedies.

Physical Optics

Interference : Interference by Division of Wavefront : Fresnel's Biprism and itsapplications to determination of wave length of sodium light and thickness of amica sheet, Lioyd's mirror, phase change on reflection.

STATISTICAL MECHANICS (8 Marks)

Probability, some probability considerations, combinations possessing maximumprobability, combinations possessing minimum probability, distribution ofmolecules in two boxs. Case with weightage (general). Phase space,microstates and macrostates, statistical fluctuations constraints and accessibleStates Thermodynamical probability.Postulates of Statistical Physics. Division of Phase space into cells, Condition ofequilibrium between two system in thermal contact. b-Parameter. Entropy andProbability, Boltzman's distribution law. Evaluation of A and b. Bose-Einsteinstatistics, Application of B.E. Statistics to Plancks's radiation law, B.E. gas. Fermi-Dirac statistics, M.B. Law as limiting case of B.E. Degeneracy and B.E.,Condensation. F.D. Gas, electron gas in metals. Zero point energy. Specific heatof metals and its solution.

Optics – II (8 Marks)

Interference by Division of Amplitude: Colour of thin, films, wedge shaped film,Newton's rings. Interferometers: Michelson's interferometer and its application to (I) Standardisation of a meter (II) determination of wave length. Fresuel'sDiffraction : Fresnel's half period zones, zone plate, diffraction at a straight edge,rectangular slit and circular apperture.

Fraunhoffer diffraction : One slit diffraction, Two slit diffraction N-slit diffraction,Plane transmission granting spectrum, Dispersive power of a grating , Limit ofresolution, Rayleigh's criterion, resolving power of telescope and a grating.

Polarization : Polarisation and Double Refraction : Polarisation by reflection,Polarisation by scattering, Malus law, Phenomenon of double refraction,Huytgen's wave theory of double refraction (Normal and oblique incidence),Analysis of Palorised light : Nicol prism, Quarter wave plate and half wave plate,production and detection of (i) Plane polarized light (ii) Circularly polarized lightand (iii)Elliptically polarized light, Optical activity, Fresnel's theory of rotation,Specific rotation, Polarimeters (half shade and Biquartz).

SOLID STATE PHYSICS (10 Marks)

Crystalline and glassy forms, liquid crystals. Crystal structure, periodicity, lattice and basis,crystal translational vectors and axes. Unit cell and primitive cell, Winger Seitz primitive Cell, symmetry operations for a two dimensional crystal, Bravais lattices in two and three dimensions. crystal planes and Miller indices, Interplanner spacing, Crystal structures of Zinc sulphide, Sodium Chloride and diamond, X-ray diffraction, Bragg's Law and experimental x-ray diffraction methods, K-space. Reciprocal lattice and its physical significance, reciprocal lattice vectors, reciprocal lattice to a simple cubic lattice, b.c.c and f.c.c. Specific heat : Specific heat of solids, Einstein's theory of specific heat, Debye model of specific heat of solids.

QUANTUM MECHANICS (10 Marks)

Failure of (Classical) E.M. Theory. quantum theory of radiatio (old quantum theory), Photon,photoelectric effect and Einsteins photoelectric equation compton effect (theory and result).

Inadequancy of old quantum theory, de-Broglie hypothesis. Davisson and Germer experiment. G.P. Thomson experiment. Phase velocity group velocity, Heisenberg's uncertainty principle. Time-energy and angular momentum, position uncertainty Uncertainty principle from de-Broglie wave, (wave-partice duality). Gamma Ray Maciroscope, Electron diffraction from a slit.

Derivation of time dependent Schrodinger wave equation, eigen values, eigen functions, wave functions and its significance. Normalization of wave function, concept of observable and operator. Solution of Schrodinger equation for harmomic oscillator ground states and excited states.

Application of Schrodinger equation in the solution of the following one-dimensional problems : Free particle in one dimensional box (solution of schrodinger wave equation, eigen function, eigen values, quantization of energy and momentum, nodes and antinodes, zero point energy).

i) One-dimensional potential barrie $E>V_0$ (Reflection and Transmission coefficient.
ii) One-dimensional potential barrier, $E>V_0$ (Reflection Coefficient, penetration of leakage coefficient, penetration depth).

ATOMIC MOLECULAR AND LASER PHYSICS (10 Marks)

Vector atom model, quantum numbers associated with vector atom model, penetrating and non- penetrating orbits (qualitiative description), spectral lines in different series of ailkali spectra, spin orbit interaction and doublet term seperation LS or Russel-Saunder Coupling jj coupling (expressions for inteaction energies for LS and jj coupling required).

Zeeman effect (normal and Anormalous) Zeeman pattern of D 1 and D2 lines of Na-atom,Paschen, Back effect of a single valence electron system. Weak field Strak effect of Hydrogen atom.

Discreet set of electronic energies of molecules. quantisation of Vibrational and ratiationalenergies Raman effect (Quantitative description) Stoke's and anti Stoke's lines.

Main features of a laser : Directionality, high intensity, high degree of coherence, spatial andtemporal coherence, Einstein's coefficients and possibility of amplification, momentum transfer, life time of a level, kinetics of optical obsorption. Threshold condition for laser emission, Laser pumping, He-Ne laser and RUBY laser (Principle, Construction and Working). Applications of laser in the field of medicine and industry.

NUCLEAR PHYSICS (10 Marks)

Nuclear mass and binding energy, systematics nuclear binding energy, nuclear stability, Nuclear size, spin, parity, statistics magnetic dipole moment, quadrupole moment (shape concept), Determination of mass by Bain-Bridge, Bain-Bride and Jordan mass spectrograph, Determination of charge by Mosley law Determination of size of nuclei by Rutherford Back Scattering.

Interaction of heavy charged particles (Alpha particles), alpha disintegration and its theoryEnergy loss of heavy charged particle (idea of Bethe formula, no derivation), Energetics of alpha -decay, Range and straggling of alpha particles. Geiger-Nuttal law.

Introduction of light charged particle (Beta-particle), Origin of continuous beta-spectrum(neutrino hypothesis) types of beta decay and energetics of beta decay, Energy loss of beta-particles (ionization), Range of electrons, absorption of beta-particles.

Interaction of Gamma Ray, Nature of gamma rays, Energetics of gamma rays, passage of Gamma radiations through matter (photoelectric, compton and pair production effect) electron position anhilation. Asborption of Gamma rays (Mass attenuation coefficient) and its application.

Nuclear reactions, Elastic scattering, Inelastic scatting, Nuclear disintegration, photonuclear reaction, Radiative capture, Direct reaction, heavy ion reactions and spallation Reactions,conservation laws. Q-value and reaction threshold. Nuclear Reactors General aspects of Reactor design. Nuclear fission and fusion reactors (Principles, construction, working and use) Linear accelerator, Tendem accelerator, Cyclotron and Betatron accelerators.

Ionization chamber, proportional counter, G.M. counter detailed study, scintillation counter and semiconductor detector.