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SYLLABUS
M. Phil and Ph. D. Entrance Test (w.e.f.2018-19)
In accordance with Revised M. Phil. and Ph.D. Ordinances

PHYSICS

The Question paper of the Entrance test will have two sections A and B, each consisting of 50 objective type compulsory questions. The section A will represent a component of "Research Methodology" whereas section B shall be "Subject Specific". Each question will carry one mark.

i. There will be no negative marks
ii. The duration of the Entrance test will be Two hours.
iii The candidate must score minimum 50% marks in the Entrance test to qualify for the interview.

(Time 2 Hours) **PART –A & B** **(Max Marks 100)**

PART –A

Part –A shall consist of 50 objective type compulsory questions of 1 mark each based on Research Methodology. It shall be of generic nature, intended to assess the Research aptitude of the candidate. It will primarily be designed to test reasoning ability, data interpretation and quantitative aptitude of the candidate.

PART –B

I Mathematical Methods of Physics

Dimensional analysis, Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem Eigen values and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel,

Laguerre and Legendre function). Fourier series and Laplace transforms. Elements of complex analysis, analytical functions, Taylor & Laurent series, poles, residues and evaluation of integrals. Elementary probability theory random variables, binomial. Poisson and normal distributions. Central limit theorem.

II Classical Mechanics

Newton's laws, Dynamical systems, Phase space dynamics, stability analysis, Central force motions. Two body Collisions –Scattering in laboratory and Centre of mass frames. Rigid body dynamics moment of inertia tensor. Non- inertial frames and pseudo forces. Variational principle. Generalized coordinates, Largrangian and Hamiltonian formalism and equations of motion. Conservation Laws and cyclic coordinates. Periodic motion : small oscillations, normal modes. Special theory of relativity Lorentz transformations, relativistic kinematics and energy equivalence.

III Electromagnetic Theory

Electromagnetics Gauss's law and its applications Laplace and Poission equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media: boundry conditions on the fields at interfaces. Scalar and vector potentials,gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields.

IV Quantum Mechanics

Wave–particle duality. Schrodinger equation (time-dependent and time – independent). Eigen value problems (Particle in a box. harmonic oscillator, etc)Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular moment: Hydrogen atom, Stern.

Gerlach experiment. Time independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules, Identical particles, Pauli exclusion principle, spin–statistics connection.

V Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences. Thermodynamic potentials. Maxwell relations, chemical potential, phase equilibria, phase space, micro –and macro-states. Micro-canonical, canonical and noise reduction, shielding and grounding. Fourier transforms, lock–in detector, box–car integrator, modulation techniques.

VI Electronics and Experimental Methods

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo-and hetero-junction devices), devices structure, devices characteristics, frequency dependence and applications, Opto-electronic devices (solar cell, Photo detector, LEDs).Operational amplifier and their application. Digital techniques and applications (Registers, counters, comparators and similar circuits).A/D and D/A converters, Microprocessor and Microcontroller basics. Data Inter pretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Linear and non linear curve fitting, Chi-square test, Transducers (Himpertions pressure/vacuum, magnetic fields, vibration, optical and particle detectors).Measurement and control Signal conditioning and recovery. Impedance matching, amplification(op-amp based, instrumentation amp, feedback).filtering and noise reduction, Shielding and grounding. Fourier transforms, Lock-in detector, box –car integrator, modulation techniques, High frequency devices (including generators and detectors).

VII Atomic & Molecular Physics

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom,

hyperfine structure and isotopic shift, width of spectrum lines.LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules , selection rules. Lasers spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, Population inversion, rate equation. Modes of resonators and coherence length.

VIII Condensed Matter Physics

Bravais lattices, Reciprocal lattice, Diffraction and the structure factor. Bonding of solids. Elastic properties, phonos, lattice specific heat. Free Electron Theory and Electronic specific heat. Response and relaxation phenomena. Drudge mode of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids, Matter, Insulators and semiconductors, Superconductivity, type–I and type- II superconductors. Josephson junctions. Superfluidity, Defects of dislocation. Ordered Phases of matter: translational and orientational order, Kinds of liquid crystalline order, quasi crystals.

IX Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon –nucleon potential, charge –independence and charge–symmetry of nuclear forces. Deutron problem. Evidence of shell structure, single-particle shell model, Its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions. reactions mechanism, compound nuclei and direct reactions.

Classification of fundamental forces. Elementary particles and their quantum numbers(charge, spin parity, isospin, strangeness, etc,) Gellemann- Nishijima formula. Quark model, baryons and mesons. C,P, and T invariance. Application of

symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.