SYLLABUS FOR PHYSICS -
Ph.D. Entrance

I. **Mathematical Methods of Physics**

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions.

II. **Classical Mechanics**

Newton's laws. Dynamical systems, Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Non-inertial frames and pseudo forces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Poisson brackets and canonical transformations. Periodic motion: small oscillations, normal modes. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy equivalence.

III. **Electromagnetic Theory**

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, Electromagnetic waves in free space, Reflection and refraction, Dynamics of charged particles in static and uniform electromagnetic fields. Radiation- from moving charges and dipoles and retarded potentials.

IV. **Quantum Mechanics**

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems, particle in a box, harmonic oscillator, Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Time- independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli Exclusion Principle, Elementary theory of scattering: phase shifts, and born approximation.

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 grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.

VI. **Electronics and Experimental Methods**

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics. Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting,

VII. **Atomic & Molecular Physics**

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Hyper fine 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.

VIII. **Condensed Matter Physics**

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Hall effect, Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity.

IX. **Nuclear and Particle Physics**

Nuclear radii and charge distributions, nuclear binding energy, electric and magnetic moments; semi- empirical mass formula; nuclear models; liquid drop model, nuclear shell model; nuclear force and two nucleon problem; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherford scattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators and detectors; elementary particles; photons, baryons, mesons and leptons; quark model; discrete quantum numbers, conservation laws, isospin symmetry, charge conjugation, parity and time-reversal invariance.

RESEARCH METHODOLOGY SYLLABUS

Unit I

Research – Meaning, Scope and Significance – Type of Research – Research process – Characteristics of good research – Scientific method – Problems in research – identifying research problem – Objectivity in research.

Unit II

Hypothesis – Meaning – Sources – Types – Case study – Features of good design measurement – Meaning, need, errors in measurement, tests of sound measurement, techniques of measurement. Scaling techniques – meaning, types of scales, scale construction techniques – Sampling design – meaning. Concepts, steps in Sampling – Criteria for good sample design – Types of sample designs, probability and non-probability sample.

Unit III

Data Collection – Types of data – Sources – Tools for data collection, methods of data collection, constructing questionnaire – Pilot study – Case study – Data processing coding – Editing and tabulation of data – Data analysis.

Unit IV

Test of significance – Assumptions about parametric and nonparametric tests. Parametric tests – chi – square, t – Test, F Test, Z Test. Introduction to ANOVA, One way, Two way and three way classification.

Unit V

Interpretation – meaning, Techniques of interpretation, Report writing – significance and steps – layout of report – types of reports – oral presentation – executive summary – mechanics of writing research report – Precautions for writing report – norms for using tables, chart and diagrams – Appendix – norms of using Index and Bibliography.

References :

1. Rao K.V. Research Method for Management and Commerce – Sterling.
2. Kothari C.R. – Research Methodology.
3. Wilkinson Bhadarkar – Methodology and Techniques of Social Research.
4. Anderson et.al. – Assignment and Thesis writing.