Ph.D Entrance Syllabus
Physics

Mathematical Methods of Physics:

Dimensional analysis, Vector algebra and vector calculus, Linear algebra, matrices, Cayley-Hamilton theorem, Eigenvalues and Eigenvectors, functions (Hermite, Bessel, Laguerre, Legendre), Fourier series, Fourier and Laplace transform Taylor and Laurent series, elementary probability theories, distributions (binomial, Poisson, normal), Central limit theorem, Differential equations of first and second orders, complex analysis, analytical functions, poles, residues, and evaluations of integrals.

Classical Mechanics:

Newton's laws of motion, Dynamical systems, phase-space dynamics, Stability analysis, Theories of relativity (Lorentz transformations, relativistic kinematics, mass-energy equivalence), Conservation laws and cyclic coordinates, periodic motions (oscillations and normal modes), Generalized coordinates, rigid body dynamics (moment of inertia tensor, non-inertial frames, and pseudo-forces), variational principle, Langrangian and Hamiltonian formalism and equations of motion.

Electromagnetic Theory:

Electrostatics and its applications, Laplace and Poisson equations, Boundary value problems Magnetostatics, electromagnetic induction, free space and linear isotropic media, Scalar and vector potentials, Fresnel's law, interference, coherence, diffraction, gauge invariance, electromagnetic waves, dielectrics, and conductors, Reflection and refraction, Polarisation Dynamics of charged particles in static fields, Uniform electromagnetic fields.

Quantum Mechanics:

Wave-particle duality, Eigenvalue problems (particle in a box, harmonic oscillator, etc), wave-function in coordinate and momentum representations, commutators and Heisenberg uncertainty principle, Motion in a central potential, Orbital angular momentum, angular momentum algebra, spin, the addition of angular momenta, Time-dependent/independent perturbation theory and applications, variational methods, Fermi's golden rule, Pauli exclusion principle, Stern-Gerlach experiment, Dirac notation for state vectors, Schrödinger's equation (time dependency and independency), selection rules, identical particles, spin-statistics connection.

Thermodynamics and Statistical Physics:

Laws of thermodynamics, their consequences, and potentials (Maxwell relations, potential equilibria, chemical potential), Canonical ensembles and its types, partitional functions, phase space and states, free energy, classical and quantum statistics, Black body radiation, Planck's distribution law, the principle of detailed balance, ideal Bose and Fermi gasses.

Electronics and Experimental Methods:

Semiconductor devices, device structure, characteristics, frequency dependence and applications, Optoelectronic devices, operational amplifiers and their applications, Digital techniques and applications, A/D and D/A converters, microprocessors, and microcontrollers, Data interpretation and analysis, Precision and accuracy, Propagation and analysis of errors, Least-square fittings.