# Syllabus for Physics Master's

# Section 1: Subject Knowledge

# Please Note: A Total of 26 Questions will be asked, combining the following topics, with the difficulty level commensurate to a Master's Candidate.

#### Unit I: Mathematical Methods of Physics

Dimensional analysis, Vector algebra and calculus, Linear algebra, Matrices, Linear ordinary differential equations, Special functions, Fourier series, Fourier and Laplace transforms, Complex analysis, Elementary probability theory, Green's function, PDE, Computational techniques, Tensors, Group theory.

#### Unit II: Classical Mechanics

Newton's laws, Dynamical systems, Phase space dynamics, stability analysis, Central force motions, Two Collisions, Rigid body dynamics, Generalized coordinates, Lagrangian and Hamiltonian formalism, Conservation laws and cyclic coordinates, Special theory of relativity, Poisson brackets and canonical transformations, Symmetry, invariance, and Noether's theorem, Hamilton-Jacobi theory.

#### Unit III: Electromagnetic Theory

Electrostatics, Magnetostatics, Electromagnetic induction, Maxwell's equations, Boundary conditions at interfaces, Scalar and vector potentials, gauge invariance, Dielectrics and conductors, Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction, Dynamics of charged particles, Dispersion in plasma, Lorentz invariance, Transmission lines and waveguides, Radiation.

#### Unit IV: Quantum Mechanics

Wave-particle duality, Schrödinger equation, and uncertainty principle. Central potentials, hydrogen atom, perturbation theory, and Pauli exclusion principle. Scattering, WKB, relativistic quantum mechanics, and semiclassical radiation theory.

# Unit V: Thermodynamic and Statistical Physics

Laws of thermodynamics, Thermodynamic potentials, Maxwell relations, phase equilibria, Phase space, Eensembles and partition functions, Free energy connection with thermodynamic quantities, Classical and quantum statistics, Ideal Bose and Fermi gases, Blackbody radiation, and Planck's distribution law.

# Unit VI: Electronics and Experimental Methods

Curve fitting, chi-square test, Transducers, Measurement and control, Signal conditioning and recovery, Impedance matching, amplification, filtering and noise reduction, shielding and grounding, Fourier transforms, lock-in detector, box-car integrator, modulation techniques, High-frequency devices.

#### Unit VII: Atomic and Molecular Physics

Quantum states, electron spin, and spectra of helium and alkali atoms. Energy corrections, hyperfine structure, and isotopic shifts. LS & JJ couplings, Zeeman, Paschen-Bach, and Stark effects. ESR, NMR, and chemical shift. Franck-Condon principle, Born-Oppenheimer approximation, and molecular spectra,. Laser.

#### Unit VIII: Condensed Matter Physics

Bravais lattices, reciprocal lattice, diffraction, and structure factor. Bonding, elastic properties, phonons, and latticespecific heat. Free electron theory, Drude model, and transport phenomena (Hall effect, thermoelectric power). Band theory, Superconductivity, Defects, dislocations, ordered phases, and quasicrystals. Unit IX: Nuclear and Particle Physics

Nuclear properties, binding energy, liquid drop model, and nuclear forces. Shell model, rotational spectra, alpha, beta, and gamma decays. Nuclear reactions. Fundamental forces, elementary particles, quark model, baryons, mesons, and symmetries (C, P, T). Parity non-conservation and relativistic kinematics.

# Section 2: Fundamental Skills

Please Note: A Total of 24 Questions will be asked, combining the following topics, with the difficulty level commensurate to a Master's Candidate.

Unit I: Data Analysis Unit II: Math and Statistics Unit III: Lab skills Unit IV: Reading and Writing

# Section 3: Specific Skill Proficiency

This section has more than 30 skills. You can select the ones you are proficient in from the enrollment form. You can choose a maximum of 4 skills. Each skill contains 10 questions.

