NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI-620015

Department of Physics
Syllabus for written test

Mathematical Physics

Vector calculus, matrices, linear differential equations, complex analysis, Cauchy's theorem, singularities, residue theorem and applications, Laplace transform, Fourier analysis, tensors.

Classical Mechanics

Lagrangian formulation, Hamilton's principle, symmetry and conservation laws, Kepler problem and Rutherford scattering, oscillations, inertia tensor, orthogonal transformations, Euler angles, Hamiltonian and Hamilton's equations of motion, Hamilton-Jacobi equation. Special theory of relativity, Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory

Maxwell's equations, scalar and vector potentials, Coulomb and Lorentz gauges, electromagnetic waves in free space, non-conducting and conducting media, reflection and transmission at normal and oblique incidences, polarization of electromagnetic waves, Poynting vector, Poynting theorem, energy and momentum of electromagnetic waves, radiation from a moving charge.

Quantum Mechanics

Postulates of quantum mechanics, uncertainty principle, Schrodinger equations, step potential, finite rectangular well, tunneling from a potential barrier, particle in a box, harmonic oscillator, concept of degeneracy, hydrogen atom, angular momentum and spin, addition of angular momenta, variational method and WKB approximation, time-independent perturbation theory, elementary scattering theory, Born approximation.

Thermodynamics and Statistical Physics

Laws of thermodynamics, macrostates and microstates, partition function, free energy, calculation of thermodynamic quantities, classical and quantum statistics, degenerate Fermi gas, black body radiation and Planck's distribution law, Bose-Einstein condensation, first and second order phase transitions, phase equilibria, critical point.

Atomic and Molecular Physics

Spectra of one-and many-electron atoms; spin-orbit interaction: LS and jj couplings, fine and hyperfine structures, Zeeman and Stark effects, electric dipole transitions and selection rules,

rotational and vibrational spectra of diatomic molecules, Franck-Condon principle, Raman effect, EPR, NMR, ESR, X-ray spectra, lasers, Einstein coefficients, population inversion.

Solid State Physics

Elements of crystallography, diffraction methods for structure determination, bonding in solids, lattice vibrations and thermal properties of solids, free electron and band theory of solids, nearly free electron and tight binding models, mobility and effective mass, optical properties of solids, Kramer's-Kronig relation, dielectric and magnetic properties of solids, superconductivity; types, properties and BCS theory.

Nuclear and Particle Physics

Nuclear properties and nuclear forces, semi-empirical mass formula, liquid drop model, nuclear shell model, nuclear force and two nucleon problem, alpha decay, beta-decay, electromagnetic transitions in nuclei, Rutherford scattering, nuclear reactions, particle accelerators and detectors, elementary particles, quark model, conservation laws, isospin symmetry, charge conjugation, parity and time-reversal invariance.