DEPARTMENT OF APPLIED PHYSICS
FACULTY OF ENGG & TECH
A.M.U., ALIGARH

Syllabus for Ph.D Admissions Test 2020-21

Section B

Classical Mechanics

Newton's laws, phase space dynamics, stability analysis, central-force motion, two body collisions, scattering in laboratory and centre of -mass frames; rigid body dynamics, moment of inertia tensor ,non-inertial frames and pseudo-force;Variational principal, Lagrangian and Hamiltonian formalisms and equation of motion; Poisson brackets and canonical transformation; symmetry, invariance and conservation laws, cyclic coordinates; periodic motion; Special theory of relativity, Lorentz transformations, relativistic kinematics and mass-energy equivalence.

Electromagnetic Theory

Electrostatics: Gauss' law and its applications; Laplace and Poisson equations, boundary value problems; Magnetostatics; Biot-Savart law, Ampere's theorem, electromagnetic induction; Maxwell's equation in free space and linear isotropic media; boundary conditions on 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.

Quantum Mechanics

Wave-particle duality; wave functions in coordinate and momentums representations; Commutators and Heisenberg's uncertainty principal; Matrix representation; Dirac's bra and ket notation; Schrodinger equation (Time-dependent and time-independent);Eigenvalue problems such as particle in box, harmonic oscillator, etc; Tunnellingthrough a barrier,motion in a central potential; Orbital angular momentum,Angular momentum algebra, spin; Addition of Angular momenta; Hydrogen atom, spin-orbit coupling, fine structure; time-independent perturbation theory and application; Variational method; WKB approximation; Pauli's exclusion principal, spin-statistics connection.

Thermodynamics and Statistical Physics

Laws of thermodynamics and their and consequences; thermodynamic potentials, Maxwell relations; Chemical potential, phase equilibria ; Phase space, micro-and microstates ; Microcanonicalcanonical and grand-canonical ensembles and partition functions; free energy and connection with thermodynamic quantities, first and second order phase transitions: Classical and quantum statistics, ideal Fermi and Bose gases; principle of detailed balance; Blackbody radiation and Planck's distribution law; Bose- Einstein condensation; Random walk and Brownian motion; Introduction to nonequilibrium processes; Diffusion equation.

Electronics

Semiconductor device physics including diodes, junctions,transistors, field effect devices, homo and heterojunction devices, device, structure, device characteristics, frequency dependence and applications; Optoelectronics device including solar cells, photodetectors and LEDs; High frequency devices including generators and detectors; Operational amplifiers and their applications.

Atomic& Molecular Physics

Quantum states of an electron in an atom; electron spin; Stern-Gerlach experiment; spectrum of Hydrogen, helium and alkali atoms: Relativistic correction for energy levels of hydrogen; hyperfine structure and isotopic shift; width of spectral lines; LS&JJ coupling; Zeeman PaschenBack &Stark effect, X-ray spectroscopy; Electrons spin resonance Nuclear magnetic resonance,chemical shift; Rotational, Vibrational, electronic, and Raman spectra of diatomic molecules; Frank -Condon principle and selection rules; Spontaneous and stimulated emission, Einstein A&B coefficients; Lasers, optical pumping, population inversion, rate equation; Modes resonators and coherence length

Characterization Techniques

X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, optical microscope and their description,Operation, principle and applicationfor analysis of materials, UV-VIS,IR Spectrophotometers, principle of operation and applications for bandgap, measurements, Magnetic and electrical measurements.

Specialization: Nanotechnology

Review of Nanotechnology, Ideas about building things with atom, possible applications in Science & Technology, Ethical aspects of Nanotechnology, Quantum Wells, Wires and Dots: Introduction, Size and Dimensionally effects, Size effects, Conduction electrons and dimensionality, Fermi gas and density of states, potential wells, partial confinement, properties dependent on density of states, Excitons, Nanotechnology in carbon materials;Fullerene and Carbons nanotubes , Fullerenes as nano-structures ,Structure of C_{60} $C_{70}$and higher fullerenes,Electronic properties of fullerenes ,Carbon tubes as Nano-structures, Observation of carbon nanotubes, structure of carbon nanotubes ,Electronic structure of Carbon nanotubes.

Condensed Matter Physics.

Bravais lattices; reciprocal lattice, Diffraction and the structure factor, Bonding of solid , Elastic properties phonons, lattice specific heat, Free electrons theory and electronics specific heat ; Response and relaxation phenomena; Drude model of electrical and thermal conductivity; Hall effect and thermoelectric power, Diamagnetism, paramagnetism and ferromagnetism; electron motion in a periodic potential, band theory of metals, insulators and semiconductors; Superconductivity; Defects and dislocations; Ordered phases of matter, translational and orientational order, kinds of liquid crystalline order, conducting polymers; Quasicrystals.

Nuclear Physics/High Energy Physics

Basic nuclear properties: size, shape, charge distribution, spine and parity; Binding energy, semi- empirical mass formula; liquid drop model; Fission and fusion; Nature of the nuclear forces, form of nucleon-nucleon potential: Charge-independence and charge-symmetry of nuclear forces; Isospin; Deuteron 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; Nuclear reactions, reaction mechanisms, compound nuclei and direct reactions; Classification of fundamental forces.

****