Malaviya National Institute of Technology Jaipur
Department of Physics
Physics Syllabus for Ph.D entrance exam

MathematicalPhysics

Vector calculus, linear vector space: basis, orthogonality and completeness; matrices; similaritytransformations, diagonalization, eigenvalues and eigenvectors; linear differential equations: secondorder linear differential equations and solutions involving special functions; complex analysis:Cauchy-Riemann conditions, Cauchy's theorem, singularities, residue theorem and applications;Laplace transform, Fourier analysis; elementary ideas about tensors: covariant and contravarianttensors.

ClassicalMechanics

Lagrangian formulation:D'Alembert's principle, Euler-Lagrange equation, Hamilton's principle,calculus of variations; symmetry and conservation laws; central force motion: Kepler problem andRutherfordscattering;smalloscillations:coupledoscillationsandnormalmodes;rigidbodydynamics: interia tensor, orthogonal transformations,Euler angles, Torque free motion of asymmetric top; Hamiltonian and Hamilton's equations of motion; Liouville's theorem; canonicaltransformations:action-anglevariables,Poissonbrackets,Hamilton-Jacobiequation.

Specialtheoryofrelativity:Lorentztransformations,relativistickinematics,mass-energyequivalence.

ElectromagneticTheory

Solutionsofelectrostaticandmagnetostaticproblemsincludingboundaryvalueproblems;methodofimages; separation of variables; dielectrics and conductors; magnetic materials; multipoleexpansion; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges;electromagneticwavesinfreespace,non-conductingandconductingmedia;reflectionandtransmission at normal and oblique incidences; polarization of electromagnetic waves; Poyntingvector, Poynting theorem, energy and momentum of electromagnetic waves; radiation from a movingcharge.

QuantumMechanics

Postulates of quantum mechanics; uncertainty principle; Schrodinger equation; Dirac Bra-Ketnotation, linear vectors and operators in Hilbert space; one dimensional potentials: step potential,finite rectangular well, tunneling from a potential barrier, particle in a box, harmonic oscillator; twoand three dimensional systems: concept of degeneracy; hydrogen atom; angular momentum andspin; addition of angular momenta; variational method and WKB approximation, time independentperturbation theory; elementary scattering theory, Born approximation; symmetries in quantummechanicalsystems.

ThermodynamicsandStatisticalPhysics

Laws of thermodynamics; macrostates and microstates; phase space; ensembles; partition function,freeenergy,calculationofthermodynamicquantities;classicalandquantumstatistics;degenerateFermigas;blackbodyradiationandPlanck'sdistributionlaw;Bose-Einsteincondensation;firstandsecondorderphasetransitions,phaseequilibria,critical point.

AtomicandMolecularPhysics

Spectra of one-and many-electron atoms; spin-orbit interaction: LS and jj couplings; fine andhyperfine structures; Zeeman and Stark effects; electric dipole transitions and selection rules;rotational and vibrational spectra of diatomic molecules; electronic transitions in diatomic molecules,Franck-Condonprinciple;Ramaneffect;EPR,NMR,ESR,X-rayspectra;lasers:Einsteincoefficients,populationinversion,twoandthreelevelsystems.

SolidStatePhysics

Elements of crystallography; diffraction methods for structure determination; bonding in solids; latticevibrations and thermal properties of solids; free electron theory; band theory of solids: nearly freeelectronandtightbindingmodels;metals,semiconductorsandinsulators;conductivity,mobilityandeffectivemass;Opticalpropertiesofsolids;Kramer's-Kronigrelation,intra-andinter-bandtransitions; dielectric properties of solid; dielectric function, polarizability, ferroelectricity; magneticproperties of solids; dia, para, ferro, antiferro and ferri-magnetism, domains and magnetic anisotropy;superconductivity: Type-I and Type II superconductors, Meissner effect, London equation, BCSTheory, fluxquantization.

Electronics

Semiconductorsinequilibrium:electronandholestatisticsinintrinsicandextrinsicsemiconductors;metal-semiconductorjunctions;Ohmicandrectifyingcontacts;PNdiodes,bipolarjunctiontransistors, field effect transistors; negative and positive feedback circuits; oscillators, operationalamplifiers, active filters; basics of digital logic circuits, combinational and sequential circuits, flip-flops,timers,counters,registers, A/DandD/Aconversion.

NuclearandParticlePhysics

Nuclear radii and charge distributions, nuclear binding energy, electric and magnetic moments; semi-empiricalmassformula;nuclearmodels;liquiddropmodel,nuclearshellmodel; nuclearforceandtwo nucleon problem; alpha decay, beta-decay, electromagnetic transitions in nuclei; Rutherfordscattering, nuclear reactions, conservation laws; fission and fusion; particle accelerators anddetectors;elementaryparticles;photons,baryons,mesonsandleptons;quarkmodel;conservationlaws,isospinsymmetry,chargeconjugation,parityandtime-reversalinvariance.