Courses run in the Department

1. M.Sc (Applied Physics)

M. Sc (Previous)

1. Mathematical Physics (PH 501)

Complex Variables

Branch points, Branch lines, Multivalued function, Derivative of complex function, Analyticity, Analytic function, Cauchy- Riemann equations, construction of a complex function, singular points, Couchy's integral theorem, Couchy's integral formula, Derivative of a Analytic function, singularities of an analytic function, Evaluation of definite integrals.

Tensors

Introduction, Covarient and Contravariant tensors, Indicial and summation convention, Dummy and real indices, Kronecker delta symbol, Tensors of higher ranks, Algebric operations of tensors, Fundamental tensors, Tensors form of gradient, Divergence, Laplacian and curl, Divergence of a tensors, Tensors in Elasticity.

Vectors & Matrices

Orthogonal curvililinier coordinates, Lineare Vector space, Linear independeance and Dependance of vectors, Basis and expansion theorem, Inner – product and unitary space.
Special types of matrices, Hermition and skew Hermition matrices, Orthogonal unitary matrices, Eigen values, Eigen Vectors, Caley Hamilton theorem, characteristic of matrix, Trace of matrix.

Special Function

Bessel, Legender, Hermite, Laguerre's, Differential Equations and Polynomials, Gauss Hyper geometriv and Confluent Hyper geometric functions.

Integral Transforms

Laplace transforms, Convolution first and second shifting theorem, Inverse Laplace transform by partial fraction, LT of derivatives.
Fourier series. FS of arbitrary period, fourier integral and transforms, Applications of laplace transforms to the initial and boundary value problems.

Dirac Delta and Greens Functions

Dirac Delta function, derivative of Dirac Delta functions, Greens functions, Three dimensional Green's functions, Greens's functions for Laplace and Poission's equations. Green's functions for wave equations.

Books

1. Mathematics for Engineers & Physicist- L.A.Pipes and L.R.Harvill.
2. Mathematical methods for Physics by G. Arfken.
3. Theoritical Physics vol. I & II – P.M. Morse and H. Feschback.
4. Special Functions by W.W. Bell.
5. Methods of Mathematical physics by R.Courant and D. Hilbert.
6. Mathematical for Physics by Mary I, Boas.
7. Mathematical methods by P.K. Chattopadhyay.

2. Classical & Statistical Mechanics (PH-502)

CLASSICAL MECHANICS

Lagrangian formulation

Generalized co-ordinates, D'Alembert's principle and Lagrange's equation of motion, Velocity – dependent potentials and Rayleigh's dissipation function, Simple applications of the Lagrangian formulation.
Hamilton's principle, some techniques of calculus of variations, Derivation of Lagrange's equation from Hamilton's principle, Extension of Hamilton's principle to non- holonomic systems, Conservation theorems and symmetry properties.

The Hamilton's equations of motion

Legendre transformation and the Hamilton's equation of motion, cyclic co-ordinates and conservation theorems, Derivation of Hamilton's equations from a variational principle, The principle of least action.
The equation of canonical transformation, Poisson brackets and other canonical invariants, Equations of motion, Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, The angular momentum Poisson bracket relations.

Hamilton Jacobi Theory

The Hamilton Jacobi equation for Hamilton's principal function, The harmonic oscillator problem, The Hamilton Jacobi equation for Hamilton's characteristic function, action angle variables.

Small Oscillations

Types of oscillations, Small oscillations using generalized coordinates, Normal modes and normal coordinates, Normal modes and normal co-ordinates, Coupled pendulum, Triatomic molecule and particles on a string.

Rigid Body Motion

Transformation from space fixed axis to body fixed axis, Euler's equations of motion, coriolis force, Moment of inertia tensor.

STATISTICAL MECHANICS

Basic Concepts

Statistical formulation of the mechanical problem, Macroscopic and microscopic states, Phase space, Concept of ensembles, Postulate of equal a priori probability, Behavior of density of states, Density distribution in phase space, Liouville's theorem, statistical equilibrium, Distribution of energy between macroscopic systems, approach to thermal equilibrium, Entropy and its properties, Virial theorem.

Classical Stastical Mechanics

Microcanonical ensemble, Canonical ensemble and Grand canonical ensemble, Calculation of mean values and fluctuations, properties of partition function, Thermodynamical variables in terms of partition function, ideal gas , Gibb's paradox, The equipartitian theorem and its applications, Paramagnatism, law of atmosphere, Maxwell's velocity distribution, Calculation of average, r.m.s. and most probable speed.

Quantum Statistical Mechanics

Quantum distribution functions (Bose Einstein & Fermi Dirac), Boltzmann limit for Bosons and Fermions, partition function for ideal gas, Equation of state, Partition function for diatomic molecule.

Ideal Bose System

Photon gas, Specific heat from lattice vibrations, Bose-Einstein condensation.

Ideal Fermi System

Fermi energy, Mean energy of Fermions at T = 0 K, Fermi gas in metals, Fermi energy as a function of the temperature, Electronic specific heat, Compressibility.

Books:

1. E.S.R.Gopal - Statistical Physics
2. Patharia - Statistical Mechanics
3. L.D.Landau & I.M.Lifshitz - Statistical Mechanics
4. Goldstein - Classical Mechanics
5. Reif – Statistical Physics

3. Quantum Mechanics (PH-503)

Introduction to Quantum Mechanics

Historical development of Quantum Mechanics, Fundamental concepts: Uncertainty principle, wave function, Schrödinger equation, eigen value and eigen functions. One dimensional potential problems, spherically symmetric cases, application to Simple harmonic oscillator and Hydrogen atom.

General Formalism of Quantum Mechanics

Representation of states and dynamical variables and observables, Hermitian operators, completeness and closure property, commutability, commuting observables, simultaneous diagonalization of commuting operators, commutator algebra, Dirac bra and ket notations, matrix representation of an operator, change of basis, unitary transformation and projection operator, Equation of motion, Schrödinger, Heisenberg and interaction pictures.

Angular Momentum

Parity or space inversion, rigid rotator as application of parity operator, rotation operators, angular momentum, eigen values and eigen functions of L^2 and Lz operators, ladder operators, Pauli theory of spins, spin polarisation, addition of angular momentum, computation of Clebsh-Gordon coefficients.

Identical Particles & Spin

Physical meaning of identity, symmetric and anti-symmetric wave functions, construction from unsymmetrized functions, The Pauli's exclusion principle.

Approximate Methods

Variational method, application to harmonic oscillator and helium atom (two electron system), time–independent perturbation theory non-degenerate and degenerate cases, Stark effect, time dependent perturbation theory, harmonic perturbation, transition probability, Fermi's Golden rule.

Books

1. Powell & Crasemann: - Introduction to Quantum Mechanics
2. Schiff: - Quantum Mechanics
3. Raims:-Wave Mechanics
4. E. Merzbacher: - Quantum Mechanics
5. A.Messiah:- Quantum Mechanics
6. B. K. Agarwal and Hari Prakash- Quantum Mechanics
7. Eisberg- Quantum Mechanics

4. Atomic & Molecular Physics (PH-504)

Hydrogen atom gross structures

Schrödinger's equation, stationary states, solution of Schrödinger's equation for Coulomb field, quantum numbers n, l, m, comparison with Bogr's model, the hydrogen spectrum.
The Hydrogen atom fine structure : Electron spin, Stern-Gerlach experiment, the interaction terms, relativistic correction, spin-orbit interaction, vector model, spectroscopic terms and selection rules, lamb shift, summary of the hydrogen spectrum.

Two electron system

Electrostatic interaction and exchange degeneracy, ground and excited states of helium. Electron spin functions and Pauli's exclusion principle, periodic table.
The central field approximation; the central field. Thomas Fermi-potential, The gross structure of alkalis atoms.

Angular problems in many electron atoms

The L-S coupling approximation, allowed terms in L-S coupling, fine structure in L-S coupling, J-J coupling, hyperfine structures, Interaction with external field: Zeeman, Paschen-Back and Stark effects.

Observed molecular spectra and their representation by Empirical formula

Spectra in visible and ultraviolet regions, spectra in the infrared region, Radio frequency spectra, Raman spectra.

Interpretation of Infrared and Raman Spectra

Interpretation of the Principle features of infrared and Raman spectra by means of the models of the Rigid Rotator and of the harmonic oscillator, interpretation of the line details of infrared and Raman spectra by means of the models of an harmonic oscillator. Non rigid rotator vibrating rotator and symmetric top, Intensities in rotation-vibration spectra, symmetry properties of rotational levels.

Electronic states and Electronic transitions

Electronic energy and total energy, vibrational sructures of electronic transitions, rotational structures of electronic bands, intensity distribution in the vibrational structure, Frank-Condon principle.

Lasers

Spontaneous and stimulated emission , optical pumping, population inversion, coherence (temporal and spatial) , three level-four level system, optical resonators, CO_2 a nd He-Ne lasers and Excimer laser.

Books:

1. G. K. Woodgate : Elementary Atomic Sturucture, Mc Graw Hill
2. H. S. Mani : Introduction to Modern Physics, East West Press
3. G. Herzberg: Molecular Spectra
4. C. N. Banwell : Fundamentals of Molecular Spectroscopy
5. W. Demtroder : Laser Spectroscopy
6. O. Sevelto : Principle of Lasers
7. K. Shunoda : Introduction to Laser Physics
8. H. E. White : Introduction to Atomic Spectra

5. Solid State Physics (PH-505)

X-ray Diffraction

Laue derivation of scattered wave (Laue condition), Diffraction condition in terms of reciprocal lattice vector, Introduction to Crystal Structure, Structure factor for a basis, Atomic from factor, Calculation of structure factor for BCC, FCC and Diamond Structure.

Phonons and Lattice Vibration

Vibrations of a monoatomic lattice (concept of Brillouin zone should be introduced) Vibration of a diatomic lattice, Acoustic and optical modes of vibration, Quantization of lattice vibration,

Phonons, phonon momentum, Lattice heat capacity(Einstein and Debye models), Inelastic scattering of neutrons by phonons, Anharmonic crystal interaction , Thermal conductivity and resistivity.

Crystal Binding

Types of solids; Vander Waal's solid, Ionic and covalent solids, metals, semiconductors; intrinsic and extrinsic semiconductors, Law of mass action, Electron and hole mobilities, impurity levels, p-n junction.

Free Electron Theory

Sommerefeld free electron theory of metals, Energy level and density of states in one and three dimensions, Chemical potential of a free electron gas, Heat capacity of free electron gas, DC and AC electrical conductivity of metals, Plasmons-transverse and longitudinal modes, Transparency of metals in UV region, Widemann-Franz law, Failure of free electron theory of metals.

Band Theory of Solids

Nearly free electron theory, Origin of energy gap, Electron in a periodic potential, Bloch function and theorem (with proof), Properties of Bloch function, No. of allowed states in a band, reduced zone scheme, Extended Zone Scheme, Repeated (periodic) zone scheme, Crystal momentum.

Diamagnetism and Paramagnetism

Classical Theory of Diamagnetism, Langvin theory of paramagnetism, Quantum theory of paramagnetism, Paramagnetic susceptibility of conduction electrons.

Ferromagnetism, Anti Ferromagnetism and Ferrimagnetism

Ferromagnetism-Wiess theory, Curie point, Exchange integral, Saturation magnetization and its temperature dependence, Saturation magnetization at absolute zero, Ferromagnetic domain, anisotropic energy, Transition region between domains concept of Bloch wall), Spin waves (magnons), Thermal excitation of magnons, Magnetic properties of rare ions and iron group ions, Crystal field splitting, Quenching of angular momentum, Antiferromagnetism - Neel temperature, Anti ferromagnetic magnons, Ferrimagnetism-Ferrimagnetic order.

Superconductivity

Electrical and magnetic properties of superconductor, Occurrence of superconductivity, Meissner effect, Heat capacity, Energy gap, Microwave properties, isotope effect, type I, II superconductors, thermodynamics of superconductivity, London equation, London penetration depth, Coherence length, Outlines of BCS theory, Flux Quantization in a superconducting ring, New super conducting materials.

Books:

1. Introduction to Solid Sate Physics: C.Kittel (John Wiley and Sons)
2. Solid State Physics: N.W. Ashcroft and Mermin (Saunders college, Philadelphia:CBS publishing Asia Ltd.)
3. Solid State Physics: C.M. Kachhava (Tata Mc Graw-Hill publishing Company, New Delhi)
4. Solid State Physics: Adrianus J. Dekker (Mac Millan)
5. Solid State Physics: Ibach and H.Luth (Springer Verlag, Berlin 1990)
6. Introductory Solid State Physics: H.P.Myers (Taylor & Francis)

6. Solid State Electronics (PH-506)

Network Theorems

Thevenin's, Norton's, Millman's, Compensation and Superposition Theorems, Decible notatations, Impedence Matching.

Semiconductor Devices

Shottky Diode, Tunnel Diode, UJT, LED, Liquid Cystal Diode and SCR. Operation of an N-Channel JFET, Transfer and Output Characteristics of a JFET, Parameters of JFET, JFET as an Amplifier, Bising of JFET, Principle and Operation of MOSFET in Depletion and Enhancement mode.

Operational Amplifier

Difference Amplifier, Circuit details of Op-Amp 741, Inverting and Noninverting Configurations, Measurement of Op-Amp parameters, Frequency Response of Op-Amp, Op-Amp Applications-Mathematical Operations, Solution of Differential Equations, High Resistance Voltmeter

Digital Electronics

Boolean Algebra, Kranaugh Map, Karnaugh Simplifications, Don't Care Conditions, Multivibrators- Astable and Monostable, Bistable, Schmidt Trigger, Flip Flops: D, RS, JK, Master Slav JK, Register and Counters: Shift Register, Ripple Counter, Up-Down Counter, Asynchronous and synchronous Counter, Ring Counter and Sequence Generators, Memories: C-MOS, ROM, MOS, RAM, D/A and A/D Converters.

Wave Propagation

Brief idea of Space Wave, Ground Wave and Sky Wave Propagation and Earth's Ionosphere.
Modulation: Amplitude Modulation, Angular, Frequency and Phase Modulation, PPM, PDM, PWM.

Radiation and Antenna (Brief idea), Transmitters and Receivers (Basics)

Books

1.	Operational Amplifier and other Application:	Kumar & Sarkar
2.	Digital Principles and Application:	Malvino Leach
3.	Integrated Electronics:	Milman & Halkias
4.	Operational Amplifier & Linear Integrated Circuit	Coughlin, Driscol
5.	Electronic Devices and Circuit Theory	Robert L. Boylestad, Louis Nashelsky
6.	Physics of Semiconductor Devices	M. Shur
7.	Electronic Principles	Malvino

M. Sc (Final)

1. Advanced Quantum Mechanics (PH-601)

Scattering Theory:

Differential scattering cross section, incoming and outgoing solutions, Expression for the scattering amplitude, Born approximation and its validity, Green's function, partial wave analysis, optical theorem, relation between phases shift and potential, Ramsauer- Townsend effect, scattering by a square well potential, scattering by a hard sphere.

Relativistic Quantum Mechanics

The Dirac Equation, Dirac Matrices, Solution of the free particle, Dirac Equation with potentials, Equations of Continuity, Spin of the electron , Non realistic limit, Dirac equation, for Hydrogen atom, spin orbit coupling, covariance of the Dirac Equation , Bilinear covariants, hole theory, the Wele's equation for the neutrino, non conservation of parity, The Klein – Gordan Equation , Charge and Current densities, the Klein-Gordan equation with potentials, Wave Equation for the photon, charge conjugation for the Dirac Weyl and Klein- Gardon equation.

Quantization of fields:

The principles of canonical quantization of fields, Lagrangian density and Hamiltonian density, Second quantization of the Shrodinger wave field for Bosons and fermions, quantization of the electromagnetic fields, second quantization of the Dirac and Klien – Gardon fields,

Reference:

1. B. K. Agarwal & Hari Prakash- Quantum Mecahnics
2. E. Merzbacher- Quantum Mechanics'
3. Schiff- Quantum Mechanics
4. Sakurai- Advanced Quantum Mechanics

2. Classical Electrodynamics (PH-602)

Maxwell's equations and conservation laws

Maxwell's equations, vector and scalar potentials, Guage transformations, Lorentz gauge, Coulomb gauge, Green functions for the wave equation, Poynting's theorem and conservation of energy and momentum for a system of charged particles and electromagnetic fields, Transformation properties of electromagnetic fields and sources under rotations, Spatial reflections and time reversal.

Plane Electromagnetic Waves and Wave Propagation

Plane waves in a nonconducting medium, Linear and circular polarization, Stokes' parameters, Reflection and refraction of electromagnetic waves at a plane interface between two dielectrics, Polarization by reflection, total internal reflection, Goss-Hanchen effect, frequency dispersion characteristics of Dielectrics, Conductors and plasmas, Waves in a conducting medium, Illustration of the spreading of a pulse as it propagates in a dispersive medium, Kramers Kronig relations.

Wave Guides and Resonant Cavities

Cylindrical cavities and wave guides, Modes in a rectangular waveguide, Energy flow and Attenuation in Waveguides, Resonant Cavities, Power losses in a cavity, Q of a cavity.

Radiating Systems, Multipole Fields

Fields and radiation of a localized oscillating source, Electric dipole fields and radiation, magnetic dipole and Electric Quadrupole fields.

Special Theory Of Relativity

Lorentz Transformations and Basic Kinematic Results of Special Relativity, Addition of velocities; 4-velocity, Relativistic momentum and energy of a particle, vector and tensor calculus, matrix representation of Lorentz transformations, Infinitesimal generators, Thomas Precession, Invariance of Electric charge, Co-variance of Electrodynamics, Transformation of Electromagnetic fields, Lagrangian and Hamiltonian for a relativistic charged particle in external electromagnetic fields, canonical and symmetric stress tensors conservation laws, solution of the wave equation in co-variant form, Invariant green functions.

Radiation by Moving Charges

Lienard-Wiechert potentials and fields for a point charge, Total power radiated by an accelerated charge: Larmor's formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge, Thomson scattering of radiation, Radiative reaction force from conservation of energy, Abraham- Lorentz evaluation of the self force, Level Breadth and level shift of a radiating oscillator, scattering and absorption of radiation by an oscillator.

Books:
Classical Electrodynamics – J.D.Jackson.
Classical Electromagnetism-Jerrold Franklin

3. Nuclear and Particle Physics (PH-603)

Basic Nuclear Properties

Mass, Charge, Size and density of nucleus. Constituents of nucleus, Distribution of nucleons. Mass defect, binding energy and packing fraction. Semi-empirical mass formula. Mass parabolas for isobaric nuclei. Quantum numbers for individual nucleons, Parity and Isospin, nuclear magnetic moment, Quadrupole moment and Quadrupole interaction energy.

Particle Radioactivity and Nuclear Models

Emission of Alpha, Beta and Gamma rays. Gamow theory of α-decay, Beta ray spectroscopy. Fermi theory of Beta decay.
Liquid drop model. Evidence of nuclear shell structure. Shell model: It's validity and limitations. Collective model.

Nuclear Forces and Nuclear Reactions

Nature of Nuclear forces. Elements of two–body problem. The Deuteron: Ground and Exited state. Meson Theory of Nuclear forces. Spin dependence of nuclear forces.
Conservation laws. Various types of Nuclear Reactions. Nuclear Reaction Kinematics. Q-value, Threshold energy. Compound nucleus. Direct reactions. Stripping and pick-up reactions.

Nuclear Energy and Nuclear Reactors

Nuclear fission and fusion reactions. Mass and energy distribution in fission fragments. Spontaneous fission. Bohr and Wheeler's theory of Nuclear fission. Neutron cycle in chain reactions. Four factors formula. Components of nuclear fission reactors. Controlled thermonuclear reactions. Theoretical aspects of nuclear fusion reactors. Conditions of breakeven and ignition, confinement, pinch effect etc.

Elementary Particles

Classification and important properties of elementary particles. Leptons, Baryons, Mesons and Hyperons. Particle and Antiparticle. Various types of interactions existing in nature: Gravitational, Electromagnetic, Weak and Strong interactions. Conservation Laws in fundamental interactions.

Excited state and resonance. Gellmann Nishijima formula. Quark Model. C.P.T. invariance in different interactions. Parity non conservation in weak interactions.

Books:

1. Segre: Nuclei and Particle
2. Cohen: Nuclear Physics
3. Enge: Nuclear Physics
4. Preston and Bhaduri: Physics of Nucleus
5. Elton: Introductory Nuclear Theory
6. Bethe: Nuclear Physics
7. Blatt and Weiscopff: Nuclear Physics
8. Kaplan: Nuclear Physics
9. W.E.Burcham and M.Jobes: Nuclear and Particle Physics

4. Nanophysics & Technology (PH-604)

Introduction

Review of Nanotechnology, Ideas about building things with atom, Possible applications in science & Technology.

NanoPhysics

Physics of low dimension system: Length scale, Quantum confinement, Particle in a 1D, 2D spherical box, Particle in a circle, Density of states of quantum well, quantum wire and quantum dot.

Techniques used in Nanotechnology

X-ray crystallography, Particle size determination, Surface structures. Microscopy: TEM, SEM, STM & AFM, Nuclear Magnetic Resonance, Chzochralski technique, CVD, Oxidation Diffusion ion implantation, Photolithography, Etching, Metalization.

(a) Properties of Individual Nanoparticles.

Metals nanoclusters, Semiconducting nanoparticles.

(b) Bulk Nanostructured Material:

Solid disordered nanostructures: Method of synthesis, Failure mechanism of conventional rain-size materials, mechanical properties, Nanostructured multilayers, Electrical properties, Metals nanocluster composite glass, Porous silicon.

(c) Quantum wells, Wires and Quantum Dots

Nanotechnology in Carbon Materials

Fullerenes and Carbon Nanotubes, Fullerene as nano structures of C-C and higher fullerene, Electronic properties of fullerene and carbon tubes as Nano-structures, Structure of carbon Nano tubes, Electronic structure of C-Nano tubes

Books

1. Introduction to Nanotechnology by C.P. Poole, Wile, Interscience (2003)
2. Nano-Technology by Gregrory Timp (Editor) AIP Press Springer (1998)
3. Carbon nanotubes Synthesis structure, Properties and Applications by M.S. Dresselhaus, G. Dresselhaus Avouris (Springer Berlin 2001)

5. Material Science (PH-605)

Experimental methods for Crystal Growth

Growth for melt: Bridgman -Stockbarger and Czocharalski method , zone melting technique
Growth by vapour : Sputtering technique
Growth from liquid solution : Hydro thermal method

Atomic Imperfections in Crystals

Point imperfections in crystals: substitutional, impurity, vacancy, interstitial etc.
Line imperfections: Edge and screw dislocation, Burger vector and Burger circuit, dislocation motion, energy of dislocation, dislocation multiplication, slip planes and slip directions, perfect and imperferct dislocation reaction
Surface imperfections: Tilt and twist boundry, Stacking faults
Color centers

Atomic diffusion in crystals

Mechanism of diffusion, Fick's second law, steady state solution- diffusion through a plane surface, diffusion through a cylinder , diffusion through a sphere; non steady-state solution, some applications of diffusion- experimental determination of diffusion coefficient , corrosion resistance of duralumin, decarburization of steel; doping in semiconductors , the Kirkendall effect, the atomic model of diffusion , diffusion in alkali halides , ionic conductivity in alkali halide crystals , diffusion and ionic conductivity.

Atomic Packing in Crystals

Close packing of spheres, Axial ratio and lattice constants, Voids in close -packing, cordination of voids, Rules governing the packing of atoms, Effect of radius ratio, Application of Pauling rules to

actual structures, Representation of closest packing, polymorphic and polytypic structures, Polytypic notations, stacking faults in fcc, hcp crystals.

Phase Diagrams

Definition, explanation of Phases, phase diagram of pure substances (water, and iron) Gibb's phase rule, Binary amorphous alloy systems, the Lever rule, Binary eutectic alloy systems , binary peritectic alloy systems, binary monotectic systems, invariant reactions, their representations and examples.

Characterization Techniques

Principles, analysis and applications of (i) I.R spectroscopy (ii) Spin resonance spectroscopy (iii) Transmission electron microscopy (TEM) (iv) Scanning electron microscopy (SEM) (v) X-ray photo electron spectroscopy (vi) Auger electron spectroscopy (AES) (vii) Raman spectroscopy

Miscellaneous Materials

Amorphous materials , Polymers, Semiconductors -III-V and II - VI compounds, Giant magneto resistance (GMR) materials, colossal magneto resistance (CMR) materials, piezo electric and ferroelectric materials.

Books:

1. Solid State Physics - M.A. Wahab
2. Amorphous Mterials - S.R. Elliot
3. Material Science - W.F. Smith

6 .Advanced Solid State Physics (PH-606)

Lattice Dynamics

General theory of lattice dynamics, Normal co-ordinate description, Quantization of lattice vibrations, Phonon concept, Inelastic scattering of slow neutrons by crystals for study of phonons, Calculations of phonons in different types of crystals.

Electronic energy band

Calculations of energy bands and Fermi surfaces and other related properties like density of states, Tight binding method, Cellular method, Muffin tin potentials, Augmented plane wave method (APW), Green's functions (KKR) method, Orthogonalized plane wave (OPW) method, Correlation.

Optical Properties

Phonon-Phonon interaction, Kramers-Kronig relations, Polarizability and dielectric constant of ionic crystals, Raman scattering by crystals, Interaction of Electromagnetic radiation of with solids, Dielectric function, Absorption of Electromagnetic radiation, Dielectric function for a harmonic oscillator, longitudinal and transverse normal mode, surface waves on a dielectric, Reflectivity of a dielectric half space, Interband transition, Excitons, Dielectric energy losses of electrons.

Excitations in imperfect crystals

Elementary ideas of Green's function method for a vibrational spectrum for point defects in imperfect crystals, ionized gap modes and resonance modes.

Many electrons system

Fermion fields, Hartree and Hartree-Fock approximation, self -consistent field method, Dielectric relation analysis, Dielectric screening random phase approximation, Dielectric constant of electron gas, Dielectric screening of a point charge impurity.

BOOKS

1. J.M. Ziman: Princiles of Solid State Physics
2. M. Born and K. Huang: Theory of Lattice Dynamics
3. G. Venkatraman: Dynamics of perfect Crystals
4. Band Structure Theory: J. Callaway
5. Lattice Dynamics Vol. II: Academic Press

2. B. Tech

(i) Physics-I (PH-101) (Credit-4)

Free Oscillations

Free oscillations in one dimension (Mass- Spring,LC circuit) longitudinal and transverse oscillations, Superposition principle, Beats ,Transverse modes of continuous string, classical wave equation, standing waves , wave velocity, Fourier analysis of a function, Fourier coefficient, Normal modes, Dispersion relation.

Forced Oscillations

Damped harmonic oscillation, steady state oscillation under periodic force, Resonance, various cases of resonance-Mechanical and electrical low pass filters.

Progressive Waves

One dimensional harmonic traveling waves, dispersive & nondispersive waves, phase velocity, index of refraction, characteristic impedance, energy transport by traveling wave, reflection and transmission, Impedance matching between two transparent media, Modulation of pulses & wave packets, group velocity, Fourier analysis, Coupled oscillations.

Interference & Diffraction

Interference between two point sources, constructive and destructive interference, Young's double slit experiment, interference at far points, relative phase coherence condition, Newton's rings; Lloyds single mirror, single slit diffraction, angular width of diffraction limited beam, angular resolution of human eye, Fraunhofer &Fresnal diffraction. Two slits & many slits diffraction pattern, Angular width of principal maxima.

Polarization

Description of polarization states, production of polarized transverse waves, Double refraction.

Some Special Topics

(a) Structure of crystalline solids, free electron model. Failure of this model, Periodic potential, Band theory. Fermi energy, metals insulators & semiconductors.
(b) Wave mechanics, Schrödinger's equation. Time independent Schrödinger's equation, Particle in a box, step potential, Tunneling phenomena.

Books

Waves and oscillation: Berkeley physics course III
Fundamental of optics: Jenkins and White
Introduction of solid state physics: C.Kittel
Solid State physics: A.J.Dekker
Quantum Mechanics: Powell
Quantum Mechanics: Singh and Bagdel
Quantum Mechanics: Schiff

(ii) Physics-II (PH-102) (Credit-4)

Electrostatics

Coulomb's law, Electric field, field due to continuous charge distribution, a line of charge, sheet of charge etc., Electrostatics potential, Potential of a charge distribution, Gradient of potential, Dipole, Field due to a dipole(general), Torque, Energy. Gauss's law and its applications, Capacitors, energy stored in capacitors.

Dielectrics

Energy of an electric field, Polarization, Dielectric constant, Susceptibility and Permittivity, Field in dielectrics, Atomic Theory, Polarizability, Cassius-Mosotti relation.

Electric Current

Electric current, Current density, Ohm's law,e.m.f., RC circuits.

Magnetic Field

Magnetic field and currents, Ampere's law, Biot-Savart's law, Motion of Charge in electric and Magnetic field, cyclotron, mass spectrograph, divergence & curl of fields. Magnetic vector potential, Magnetic dipoles, torque & energy, dipole moment, electron in an orbit.

Magnetic field in matter

Magnetization, the three magnetic vectors (B,M&H) units, susceptibility and permeability, Dia, Para, and Ferromagnetism, Magnetic domains, Hysteresis, Maxwell's equations in free space and in matter, Ferroelectrics.

Electromagnetic induction

Magnetic flux, Faraday's law, Lenz's Law, Motor & generators, Time varying magnetic field, Betatron self and mutual inductance, RC, LR and LCR circuit, Energy density in magnetic fields

Maxwell's Equations

LC oscillations, Displacement Current, Maxwell's equation in vacuum & matter (Integral and Differential form's), conservation of electromagnetic energy, Poynting theorem, Radiation from a point charge.

Electromagnetic wave

Wave equation, Plane waves, wave through non-conducting medium, Polarization, reflection and transmission, Snell's law.

Books:

1. Electricity and Magnetism: Berkley Physics Course II.
2. Electromagnetic waves & Radiating systems: Jordan and Keith.