Course Content M.Sc. (Physics) - First Semester

PT-101: MATHEMATICAL PHYSICS

Vector algebra and vector calculus, linear independence, basis expansion, Schmidt orthogonalisation. Matrices: Representation of linear transformations and change of base; Eigen values and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors, Concepts of tensors (12)

UNIT II: Complex variables (12)

Recapitulation: Complex numbers, triangular inequalities, Schwarz inequality. Function of a complex variable : single and multiple-valued function, limit and continuity; Differentiation; Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals ,Cauchy's theorem (elementary proof only), converse of Cauchy's theorem, Cauchy's Integral Formula and its corollaries; Series - Taylor and Laurent expansion; Classification of singularities; Branch point and branch cut; Residue theorem and evaluation of some typical real integrals using this theorem.

UNIT III

Theory of second order linear homogeneous differential equations

Singular points: regular and irregular singular points; Frobenius method; Fuch's theorem; Linear independence of solutions: Wronskian, second solution. Sturm-Liouville theory; Hermitian operators; Completeness. Inhomogeneous differential equations: Green's functions (12)

UNIT IV

Special functions (5)

Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions., generating function

Integral transforms (5)

Fourier and Laplace transforms and their inverse transforms, Bromwich integral [use of partial fractions in calculating inverse Laplace transforms]; Transform of derivative and integral of a function; Solution of differential equations using integral transforms, Delta function.

References:

1. Mathematical methods for physics, by G ARFEKEN
2. Matrices and Tensors for physicists, by A W JOSHI
3. Advanced engineering mathematics, by E KREYSZIG
4. Special functions , by E D RAINVILLE
5. Special functions by W W BELL
6. Mathematical method for physicists and engineers by K F REILYU, M P HOBSON and S J BENCE
7. Mathematics for physicists, by MARY L BOAS

PT-102:CLASSICAL MECHANICS

Unit-I: Preliminaries, Newtonian mechanics of one and many particle systems conservation laws, work energy theorem, open system (with variable mass). Constraints and their classifications, D'Alembert's principle's, generalized coordinates, Lagrange equation.

Unit-II: Gyroscopic forces, dissipative systems, Jacobi integral, gauge invariance, generalized coordinates and momenta, integrals of motion, symmetry of space and time with conservation laws, invariance under Gallilean transformations.

Unit-III: Rotating frames, inertial frames, terrestrial and astronomical applications, Coriolis force. Central forces, definition and charactersitics, Two-body problem, closure and stability of circuler orbits, general analysis of orbits, Kepler's laws and equations, artificial satellites, Rutherford scattering.

Unit-IV: Principle of least action, derivation of equation of motion, variation and end points, Hamilton's principles and characteristics functions, Hamilton – Jaccobi equations.

Canonical transformations, generating functions, properties, group properties, example's. Infinitesimal generators, Poison bracket ,Poison theorems, angular momentum PBs, small oscillations, normal modes and coordinates.

<u>TEXT AND REFERENCE BOOKS</u>

1. Classical Mechanics by N C RANA and P S JOAG (TATA Mc Graw-Hill,1991)
2. Classical Mechanics by H GOLDSTEIN (Addition Wesley,1980)
3. Mechanics by A. SOMMERFELD
4. Introduction to dynamics by I. PERCEIVAL and D. RICHARDS(Cambridge Univ.)

PT-103:QUANTUM MECHANICS - I

Unit-I: Why QM Revision; inadequacy of classical mechanics; Schrodinger equation; continuity equation; Ehrenfest theorem; Admissible wave functions;

Stationary states, One dimensional problems, wells and barriers; Harmonic oscillators by Schrodinger Equation

Unit-II: Uncertainty relation of x and p, States with minimum uncertainty product; General Formalism of wave mechanics; Commutation Relations; Representation of states and dynamical variables; Completeness of eigen functions ; Dirac delta function ;Bra and ket Notation; Matrix representation of an operator ; Unitary transformation. Solution of Harmonic oscillator by operator method.

Unit-III: Angular momentum in QM; Central force problems: Solution of Schrodinger equation for spherically symmetric potentials; Hydrogen atom .

Unit-IV: Time independent perturbation theory; Non-degenerate and degenerate cases; Applications such as Stark effect etc.

TEXT AND REFERENCE BOOKS:

1. Quantum mechanics, by L I Schiff
2. Quantum physics by S Gasiorowicz
3. Quantum mechanics by B Craseman and J D Powell
4. Quantum mechanics by A P Messiah
5. Modern Quantum mechanics by J J Sakurai
6. Qunatum mechanics by Mathews and Venkatesan

PT-104 Basics of Electronic Devices

UNIT I

Introduction to Electronic Materials, Energy bands, Fermi levels in intrinsic and doped semiconductors, degenerate semiconductors, derivation of intrinsic carrier concentration, carrier mobility and drift velocity, Resistivity and Conductivity, diffusion phenomenon, Haynes-Shockley experiment, Einstein's relationship, carrier injection & Direct band gap, recombination processes (direct)

UNIT II

PN junction: thermal equilibrium condition, depletion region (abrupt and linearly graded junctions), depletion capacitance: C-V characteristics, impurity distribution, I-V characteristics; generation-recombination and high-injection effects, temperature effect, charge storage and transient behaviour; minority carrier storage, diffusion capacitance, junction breakdown: tunnelling effect and avalanche multiplication; semiconductor heterojunctions.

UNIT III

Majority Carrier diodes

Tunnel diode- principle of operation and V-I characteristics, Tunnel diode as circuit element, Backward diode- basic ideas, Schottky barrier diode- Formation of barrier, Basic ideas of Schottky Mott theory, Ohmic contacts and heterojunctions

Unit IV

Other electronic devices: Electro-optic, Magneto-optic and Acousto-optic effects, Material properties related to get these effects, Important ferro electric, liquid crystal and polymeric materials for these devices, Piezoelectric, electrostrictive and magnetostrictive effects, important materials exhibiting these properties and their applications in sensors and actuator devices.

Reference books

1. Semiconductor devices- Physics and Technology by S.M.Sze
2. Introduction to semiconductor devices by M.S. Tyagi
3. Optical Electronics by Ghatak and Thyagarajan
4. Physics of Semiconductor devices by M Shur
5. Solid State Electronic devices by Streetman and Banerjee

PT-105 Laboratory

1. Measurement of wavelength of He-Ne LASER (Grating)
2. Febry Perot Interferometer (demagnification factor)
3. To determine the Planck Constant and work function
4. Determination of speed of Ultrasonic wave in water
5. Photoconductivity (Photocurrent as a function of irradiance at constant voltage)
6. Design of regulated Power Supply
7. Study of Solar Cell characteristics
8. Study of the static drain characteristics of MOSFET
9. Verification of De Morgan's Theorem
10. IC-741 (Op-Amp)

Second Semester

PT-201: Quantum Mechanics-II

Unit-I: Approximation methods, higher order time independent perturbation, Variational method, WKB approximation, turning points, applications.

Unit-II: Time dependent perturbation theory, harmonic perturbation, Fermi's golden rule, Adiabatic and sudden approximation. Semi-classical theory of radiation, transition probability for absorption and induced emission, electric dipole and forbidden transitions, selection rules.

Unit-III: Collision in 3-D and scattering, laboratory and CM reference frames, scattering amplitude, differential scattering cross section and total scattering cross section, scattering by spherically symmetric potential, partial waves and phase shifts, scattering by perfectly rigid sphere and by square well potential

Unit-IV: Identical particles, symmetric and anti-symmetric wave functions, collision of identical particles, spin angular momentum, spin function for a many electron system.

Relativistic Quantum Mechanics: Klein-Gordon and Dirac equations; Properties of Dirac matrices. Plane wave solutions of Dirace quation; Spin and magnetic moment of the electron. Nonrelativistic reduction of the Dirac equation. Spin-orbit coupling. Energy levels in a Coulomb field.

Text and Reference Books

1. L I Schiff, Quantum Mechanics (McGraw- Hill).
2. J.J. Sakurai, Modern Quantum Mechanics
3. Griffiths, Introduction to Quantum Mechanics
4. A.P. Messiah, Quantum Mechanics Vol 2, (North-Holland, 1962).
5. R. Shankar, Principles of Quantum Mechanics (Plenum 1994)
6. James D. Bjorken and Sidney D. Drell, Relativistic Quantum Mechanics (MoGraw-Hill 1964)
7. B.K. Agarwal and Hari Prakash, Quantum Mechanics (Prentice-Hall 2007)

PT-202- Statistical Mechanics

Unit-I: Connection between statistics and thermodynamics, classiccal ideal gas, entropy of mixing and Gibbs paradox.
Micro-canonical ensemble, phase space, trajectories and density of states, Lioville theorem, canonical and grand canonical ensembles, partition function, calculation of statistical quantities, energy and density fluctuations.

Unit-II: Density matrix, statistics of ensembles, statistics of indistinguishable particles.Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

Unit-III: Landau theory of phase transition, critical indices, scale transformation and dimensional analysis.

Unit-IV: Correlation of space-time dependent fluctuations, fluctuations and transport phenomena, Brownian motion, Langevin theory, fluctuation-dissipation theorem.

Text and Reference Books

1. Statistical and thermal physics, By F. Reif.
2. Statistical Mechanics, By K Huang.
3. Statistical Mechanics, By R K Patharia.
4. Statistical Mechanics, By R. Kubo.
5. Statistical Physics, By Landau and Lifshitz.

PT-203: ELECTRODYNAMICS AND PLASMA PHYSICS

Unit-I: Review of Four-vector and Lorentz transformation in four dimensional space, electromagnetic field tensor in four dimensions and Maxwell's equations, Dual field tensor, Wave equation for vector and scalar potential and solution retarded potential, Lienard-Wienchert Potential, Electric and magnetic fields due to a uniformly moving charge and accelerated charge, linear and circular acceleration and angular distribution of power radiated, Bremsstralung,

Unit-II: Motion of charged particle in electromagnetic field, Uniform E and B fields, Nonuniform fields, Diffusion across magnetic fields, Time varying E and B fields, Adiabatic invariants, First, second and third adiabatic invariant.

Unit-III: Elementary concepts of plasma, derivation of moment equation from Boltzman equation, plasma oscillations, Debye shielding, plasma parameters,

Unit-IV: Hydrodynamical description of plasma, Fundamental equations, hydrodynamic waves, magnetosonic Alfven waves, Wave phenomena in magneto plasma, polarization, phase velocity, group velocity, cut-offs, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field, Appleton-Hartee formula and propagation through ionosphere and magnetosphere,

Text and Reference Books:

1. Penofsky and Philips, Classical electricity and Magnetism.
2. Bittencourt, Plasma Physics
3. Chen, Plasma Physics.
4. Jackson, Classical Electrodynamics.
5. S.N. Sen, Plasma Physics.

PT-204: ATOMIC AND MOLECULAR PHYSICS

Unit-I: Quantum state of one electron atoms, Atomic orbits, Hydrogen spectrum Pauli's principle, Spectra of alkali elements, Spin orbit interaction and fine structure in alkali spectra.

Unit-II: Equivalent and non equivalent electrons, normal and anomalous Zeeman effect- Paschen Back effect-Stark effect, Two electron systems –interaction energy in LS and JJ coupling –Hyperfine structure (qualitative), Line broadening mechanisms (general ideas).

Unit-III: Type of molecules-Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotor – Energy levels and spectra of non rigid rotor-intensity of rotational lines –stark modulated microwave spectrometer (qualitative).

Unit-IV: Vibration energy of diatomic molecule –PQR branches, IR spectrometer (qualitative). General idea of IR and Raman spectroscopy, analysis of simple diatomic molecules, Intensities of vibrational lines. Selection rules.

Reference books:

1. Introduction to atomic spectra-H.E.White (T)
2. Fundamentals of molecular spectroscopy-C.B.Benwell (T).
3. Spectroscopy Vol. I II III- Walker & Straughen.
4. Introduction of molecular spectroscopy- G.M.Barrow.
5. Spectra of diatomic molecules –Herzberg
6. Molecular spectroscopy Jeanne L Michele
7. Molecular spectroscopy –J.M.Brown.
8. Spectra of atoms and molecules -P.F.Bernath.
9. Modem spectroscopy –J.M.Holias.

PT-205 Laboratory

1. Microwave
2. FT-IR
3. VU-VIS
4. Zeeman
5. To study the Kerr effect and to obtain the Kerr constant.
6. Faraday effect
7. To study the variation of resistivity and determine the energy gap of a semiconductor using Four Probe method
8. Refractive index measurement
9. Constant deviation spectrometer
10. To determine the wavelengths of Hydrogen spectrum and determine the value of Rydberg's constant.

Third Semester

PT-301 Computer Programming and Numerical Analysis

Unit–I: Basic computer programming, Flow chart, FORTRAN programming preliminaries, FORTRAN constants & variables

Unit–II: Arithmetic expression, I/O statements, control statements (Do, if, while loop), format specification, logical expression, Function/subroutines, File processing, Examples

Unit-III: Methods for determination of Zeroes of linear and nonlinear algebraic equations and transcendental equations ,convergence of solutions.
Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative Method, Matrix inversion.

Unit-IV: Eigen values and eigenvectors of matrices ,power and Jacobi method Finite Differences ,interpolation with equally spaced and unevenly spaced point, Curve fitting Polynomial least squares, Numerical solution of ordinary differential equation, Euler & Runga-Kutta method, Numerical integration, Trapezoidal rule, Simpson's method.

Text and Reference Books

1. Sastry : Introductory methods of Numerical Analysis

2. Rajaraman : Numerical Analysis and Fortran Programming

PT-302 Condensed Matter Physics-I

Unit-I: Crystalline solids: Unit cells, symmetry elements, 2-D and 3-D Bravais lattices, Crystal structures-sc; bcc; fcc; hcp, Miller Indices, Interplanar spacing, Atomic packing in 2-D and 3-D, Closed packed structures, Elastic constants and elastic waves in cubic crystals.

Unit-II: Interaction of X-ray with matter, Absorption of x-ray, Diffraction of X-rays by lattice, the Laue equation, Bragg's law, Ewald construction, Reciprocal lattice and its applications to diffraction techniques, Brillouin zones. The Laue powder and rotating crystal methods, crystal structure factor.

Unit-III: Electrons in a periodic lattice: Bloch theorem, band theory, classification of solids,effective mass. Tight-binding approximation, cellular, APW, OPW and pseudopotential methods. Fermi surface, De Hass van alfen effect, cyclotron resonance. Superconductivity: critical temperature, persistent current, Meissner effect, energy gap, coherence length, London equation.

Unit-IV: Classical Langevin's theory of diamagnetism, paramagnetism, and ferromagnetism. Weiss theory of paramagnetism. Antiferromagnetism, neel temperature. Point defects, line defects and planer (stacking) faults. Colour centers, the role of dislocations in crystal growth. The observation of imperfections in crystals, X-ray and electron microscopic techniques.

References

1. Aschroft & Mermin : Solid State Physics
2. C Kittel : Solid State Physics
3. Chaikin and lubensky : Principles of Condensed Matter Physics
4. M A Wahab: Solid State Physics
5. Azaroff : Introduction to solids
6. Omar : Elementary Solid State physics

PT-303 Nuclear and Particle Physics

UNIT I

Static properties of Nuclei: Nuclear size determination from electron scattering, nuclear charge distribution. Angular momentum, spin and moments of nuclei. Binding energy, semi-empirical mass formula, Liquid drop model, fission and fusion (4 Lectures)
Two Nucleon Systems & Nuclear Forces: Dipole and quadrupole moments of the deuteron, Central and tensor forces, Evidence for saturation property, Neutron-proton scattering, Proton-proton scattering, S-wave effective range theory. charge independence and charge symmetry , exchange character, spin dependence. Isospin formalism. General form of the nucleon-nucleon force. Yukawa interaction (8 Lectures)

UNIT II

Nuclear Decays: Alpha decay: Geiger-Nuttall law, Electromagnetic decays: selection rules,Fermi theory of beta decay. Kurie plot. Fermi and Gamow-Teller transitions. parity violation in beta-decay. (4 lectures)

Nuclear Models: Liquid drop model, Collective model of Bohr and Mottelson, rotational spectra, nuclear shapes. Experimental evidence for shell effects, shell model, spin Orbit coupling, Magic numbers, angular momenta and parities of nuclear ground states, Qualitative discussion and estimates of transition rates, Magnetic moments and Schmidt lines, (8 Lectures)

UNIT III

Introduction to Nuclear Reactions. Direct and compound nuclear reaction mechanism-cross sections in terms of partial wave amplitudes -compound nucleus -scattering matrix-Reciprocity theorem. Breit-Wigner one Level formula-Resonance scattering. (8 Lectures)

UNIT IV

Elementary Particles (quarks, baryons, mesons, leptons). Classification: spin and parity assignments; isospin, strangeness. Elementary ideas of SU(2) & SU(3). Gell-Mann-Nishijima scheme. C, P and T invariance and application of symmetry arguments to particle reaction. Properties of quarks and their classification. Introduction to the standard model, Electroweak interaction-W & Z Bosons. Parity non-conservation in weak interactions, Relativistic kinematics. (12 Lectures)

Text and Reference Books

1. Nuclear Physics by S.N. Ghoshal, S. Chand & Company Ltd,2004
2. Introducing Nuclear Physics by K. S. Krane (Wiley India., 2008) .
3. Nuclear Physics - Theory & Experiments by R.R. Roy & B.P.Nigarn (New Age lnternational, 2005)
4. Nuclear & Particle Physics: An Introduction by B. Martin (Willey,2006)

5. Introduction to Elementary Particles by D. J. Griffiths (Academic Press 2nd Ed.2008)
6. Concept of Nuclear Physics by B. L. Cohen (McGraw-Hill,2003)

PT-304 Material Science -I

Unit-I: Relative stability of phases and phase rule; Binary phase diagrams (Iron-C diagram), Lever rule, nucleation kinetics, growth and transformation kinetics, Applications in transformation in steel, Microstructure changes during cooling and heating. Diffusion, Fick's first and second law, some application Kirkendal effect and application in semiconductors.

Unit-II: Preparation of bulk materials : Solid state reactions method, sol-gel method, precipitation method . The film concept, preparation of thin film. Evaporation rate, Evaporation of compounds and alloys. Pirani and Penning gauges, rotary and oil diffusion pumps, Deposition of thin films by sputtering, Glow discharge and RF Sputtering, MBE.

Unit-III: Polymers, mechanism of polymerization, Molecular weight distribution in linear polymers, condensation. polymers, size distribution in polymer molecules, Effect of polymer structure on properties conducting polymer , Biopolymers.
Corrosion mechanism, galvanic corrosion, polarization phenomena, stress corrosion, corrosion resistant materials, corrosion inhibitors, cathodic protection.

Unit-IV: Ferro, antiferro and ferromagnetic materials, hysterisis losses, the importance of transition metals and alloy as ferromagnetes, hard and soft magnetic materials, spinals, garnets, ferrites and their uses in microwave application, magnetic bubbles.

Books Recommended :

1. Materials Science & Engineering : V. Raghavan
2. Elements of materials science & Engineering : L.H. Van
3. The Structure and properties of materials : R.M. Rose & J. Wulff
4. Thin film technology : K.L.Chopra

PT-305 Laboratory

1. To determine the phase diagram of Ba-Sn Alloy using Cooling curve.
2. To study B-H Curve of a given material and determine the relative permeability.
3. To measure the variation of dielectric constant with temperature and verification of Curie Wiess law.
4. Indexing of a given XRD pattern and determination of lattice parameter and crystal structure.
5. To determine the dependence of Hall coefficient on temperature and nature of majority charge carriers
6. To determine the magnetic susceptibility of a paramagnetic material ($MnSO_4$ solution, $FeCl_3$ solution) (Quinke's method)
7. To determine the characteristic of G.M. tube
8. Study of Pulse height versus operating voltage of G.M.tube
9. Verification of Inverse square law (G.M.tube)
10. To study the variation of magnetoresistance of a sample with the applied magnetic field.

Fourth Semester

PT-401 Laser Physics and Spectroscopy

UNIT-I:

Basic Principles of Laser, Two level, Three and Four level laser system, Rate equations for three and four level system, threshold pump power, Relative merits and de-merits of three and four level system, Gas and dye lasers, Application of Laser in Material Processing.

UNIT-II :

Optical resonators, Stability of resonators, Characteristics of Gaussian beam, Transverse and longitudinal modes, mode selection, losses in a resonator, mirror mounts, optical coating etc., Q-switching and Mode locking. Non-linear polarization of lasers and some applications: Second harmonic generation using non-linear optical methods.

UNIT-III :

Concepts of spectroscopy, Process of Absorption, Emission and Scattering, Dispersing devices and detectors: Dispersion and resolution of a prism and a grating spectrometer, Single and double monochromators, Photomultiplier tube, Charge coupled detectors (CCD).

UNIT-IV :

UV-visible molecular absorption spectroscopy, Molecular luminescence spectroscopy (fluorescence, phosphorescence, chemiluminescence), Infrared Spectroscopy: Instrumentation and typical applications of infrared spectroscopy (qualitative and quantitative), Raman Spectroscopy: Instrumentation, Applications of Raman spectroscopy.

Reference Books :

1. Laser Theory and Applications: K. Thyagarajan and A.K. Ghatak
2. Principles of Lasers : O. Svelto.
3. Laser Spectroscopy and Instrumentation : W. Demtroder.
4. Laser Material Processing : William M. Steen
5. Modern Spectroscopy, J. M. Hollas
6. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E.M. Mc Cash,
7. Advances in Laser spectroscopy: Edited by F.T.Arecchi
8. Laser Applications: Monte Ross

PT-402 Advanced Condensed Matter Physics-II

UNIT-I Interacting electron gas : Hartree and hartree -Fock approximations, correlation energy, plasma oscillations , dielectric function of a electron gas in random phase approximation . Strongly-interacting fermi system. Elementary introduction to landau's quasi-particle theory of a fermi liquid. Strongly Correleated

Electron gas. Elementary ideas regarding surface states, metallic surface and surface reconstruction.

UNIT-II Point -Defects : Shallows impurity states in semiconductors. Localized lattice vibrational states in solids. Vacancies , interstitials and colour centers in ionic systems.

Disorder in condensed matter, substitutional positional and topographical disorder, short and long range order. Atomic correlation function and structure descriptions of glasses and liquids.

Anderson model for random systems and electron localization , mobility edge , qualitative application of the idea to amorphous semiconductors and hopping conduction.

UNIT-III Mechanism of plastic deformation in solids, stress and strain fields of screw and edge dislocations, Elastic energy of dislocations. Forces between dislocations , stress needed to operate Frank-read source, dislocations in fcc, hcp and lattices. Partial dislocations and stacking faults in close -packed structures.

UNIT-IV Study of surface topography by multiple -beam interferometry, Conditions for accurate determination of step height and film thicknesses(Fizeau fringes). Electrical conductivity of thin films, Difference of behaviour of thin films from bulk , Boltzmann transport equation for a thin film (for diffused scattering) ,expression for electrical conductivity for thin film.

Text and Reference Books:

1. Madelung : Introduction to solid state theory
2. Callaway : Quantum theory of solid state
3. Huang : Theoretical solid state physics
4. Kittel : Quantum theory of solids.
5. Azaroff : X-ray crystallography
6. Weertman & weertman : Elementary Dislocation theory
7. Verma & Srivastave : Crystallogrphy for solid state physics
8. Kittel : Solid state physics
9. Azaroff & Buerger : the Powder Method
10. Buerger : Crystal structure Analysis
11. Thomas : Transmission Electron microscopy

PT-403 Materials Science-II

Unit-I Superconductivity : Occurrence , Meissner effect, type I and type II Superconductors, Heat capacity , energy gap, isotope effect
Theoretical survey : Thermodynamics of superconductivity , London equation , outline of BCS theory of superconductivity. Basic idea of Josephson junction and SQUIDS devices.
Unit-II Structure preparation and application of high temperature superconductivity (HTSC) : Discovery and structure of low and high temperature superconductors , general features of high Tc superconductors, preparation of HTSC materials , Application of low and high Tc superconductors
Unit-III Elementary idea of Advanced materials: Liquid crystals, Quasi-crystals, dielectric materials , Ferroelectric materials, Hydride materials (Hydrogen storage materials).
Unit-IV Materials Characterization techniques: X-ray Diffraction , Neutron diffraction , TEM, SEM, Thermal analysis , NMR, electron spectroscopy , Laser Raman spectroscopy.

Book Recommended:

1. Introduction to solid state physics : C.Kittel
2. Introduction to superconductivity : M. Tinkham
3. Superconductivity Today : T.V. Ramkrishnan and C.V. R.R
4. Introduction to superconductivity : A.C. Rose
5. Liquid Crystal : S.Chandrashekhar

PT-404 : Physics of Semiconductor devices

Unit I Microwave devices
Varactor diode- equivalent circuit and device parameters, P-I-N diode- reverse and forward V-I characteristics, IMPATT diode, TRAPATT diode, BARITT diode and their principle of operation, Basic ideas about transferred Electron devices and their applications as oscillator and amplifier

Unit II Optoelectronic devices
Photovoltaic effect in a p-n junction, p-n junction solar cell, V-I characteristics, Photodetectors- Photoconductor, Photodiode, Avalanche photodiode, Light Emitting diodes-Radiative and Non radiative transitions Excitation mechanisms, recombination of carriers, extraction of light from semiconductor, materials for LED, Diode lasers, conditions for population inversion, in active region, light confinement factor, optical gain and threshold current for lasing

Unit III Processing of devices
Semiconductor crystal growth- bulk crystal growth, epitaxial crystal growth, vapor phase epitaxy, molecular beam epitaxy, metal organic vapor deposition, Lithography- Photoresist coating, Mask generation and image transfer, Doping of semiconductors-Epitaxial doping, doping by diffusion, ion implantation, Etching- Wet chemical etching, plasma etching, reactive ion beam epitaxy, ion beam milling

Unit IV Integrated Devices
Bipolar integration- P-N junction isolation, dielectric isolation, circuit components- N-P-N transistors, diodes, resistors, capacitors, P-N-P transistors, Basic ideas about MOS integration

Reference books

1. Introduction to semiconductor materials and devices- M.S. Tyagi
2. Semiconductor devices- Basic Principles- Jasprit Singh
3. Semiconductor devices- Physics and Technology by S.M. Sze