Course Structure
M.Sc. Physics Syllabus

Department of Pure and Applied Physics
Guru Ghasidas Vishwavidalaya, Bilaspur-495 009 (C.G.)

Semester-I	Semester-II
PT-101-Mathematical Physics	**PT-201-**Atomic and Molecular Physics
PT-102-Classical Mechanics	**PT-202-** Nuclear and Particle Physics
PT-103-Quantum Mechanics-I	**PT-203-** Solid State Physics
PT-104-Basic Electronic Devices	**PT-204-** Quantum Mechanics-II
PT-105- Lab Course	**PT-205-** Lab Course
Semester-III	**Semester-IV**
PT-301- Statistical Mechanics	**PT-401-**Experimental Technique in Physics
PT-302-Introductional to Computational Physics	**PT-402-** Accelerator Physics
PT-303- Electrodynamics	**PT-403-**Molecular Physics and Group Theory
PT-304-Specilization	**PT-404- Specialization**
(i) Advanced Condensed Matter Physics-I	(i) Advanced Condensed Matter Physics-II
(ii) Nuclear Structure	(ii) Measurement Techniques and Nuclear Reaction
(iii) Astronomy and Astrophysics-I	(iii) Astronomy and Astrophysics-II
(iv) Molecular Spectroscopy	(iv) Advanced Spectroscopy
(v) Advanced Plasma Physics-I	(v) Advanced Plasma Physics-II
(vi) Material Science –I	(vi) Material Science –II
PT-305- Lab Course	**PT-405-** Project Work

M. Sc. Physics – I

PT-101: MATHEMATICAL PHYSICS

UNIT I: Vector algebra and vector calculus, linear independence, basis expansion, 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)

Function of a complex variable: single and multiple-valued function, Differentiation; Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals, Cauchy's theorem, Cauchy's Integral Formula and its corollaries; Series - Taylor and Laurent expansion; Branch point and branch cut; Residue theorem and evaluation of some typical real integrals using this theorem.

UNIT III (12)

Theory of second order linear homogeneous differential equations, Frobenius method; Linear independence of solutions: Wronskian, second solution. Hermitian operators, Completeness. Special functions Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions., generating function

UNIT IV (12)

Integral transforms

Fourier and Laplace transforms and their inverse transforms, Bromwich integral, 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. Mathematical method for physicists and engineers by K F REILYU, M P HOBSON and S J BENCE

3. Advanced engineering mathematics, by E KREYSZIG

4. Special functions , by E D RAINVILLE

5. Special functions by W W BELL

7. Mathematics for physicists, by MARY L BOAS

M.Sc. (Physics)

Semester - I

General Paper: Classical Mechanics

Unit-I

Mechanics of a Particle, Mechanics of a System of Particles, Conservation Laws, Work Energy Theorem, Constraints and Their Classifications, Degree of Freedom, Generalized Coordinates, Principle of Virtual Work, D'Alembert's Principle, Lagrange's Equation from D'Alembert's Principle, Properties of Kinetic Energy Function.

Unit-II

Gyroscopic Forces, Dissipative Forces, Rayleigh's Dissipation Function, Lagrange's Equation for Dissipative System, Linear Generalized Potential, Generalized Momenta and Energy, Jacobi Integral, Gauge Function for Lagrangian, Cyclic Coordinates, Integrals of Motion, Symmetry of Space and Time with Conservation Laws – Homogeneity and Isotropy, Invariance of Lagrange's Equation under Galilean Transformations.

Unit-III

Inertial and Rotating Frames, Inertial Forces in Rotating Frame, Coriolis Force, Coriolis Force from Lagrangian Formulation, Definition and Properties of Central Force, Two-body Central Force Problem, General Features of Central Force Motion and its Orbits, Stability of Orbits and Conditions for Closure, Motion under Inverse Square Force (Kepler's Problem) and Shapes of Orbits, Unbound Motion - Rutherford Scattering.

Unit-IV

Hamilton's Variational Principle, Lagrange's Equation from Calculus of Variations, Hamilton's Variational Principle from Lagrange's Equation, Hamilton's Canonical Equations of Motion, Hamilton's Canonical Equations from Hamilton's Variational Principle, Principle of Least Action, Canonical Transformations and Generating Functions, Example of Canonical Transformations, Condition for Canonical Transformations, Hamilton – Jaccobi Equation, Hamilton's Principal and Characteristic Functions, Poison Bracket, Invariance of Poisson Brackets with Respect to Canonical Transformations, Equations of Motion in Poisson Bracket Form, Poisson's Theorem, Angular Momentum in Poisson Bracket, Small Oscillations, Normal Modes and Coordinates.

TEXT AND REFERENCE BOOKS:

1. Classical Mechanics, N.C. Rana and P.S. Joag, TATA Mc Graw-Hill, 1991.
2. Classical Mechanics, H. Goldstein, Addition Wesley, 1980.
3. Classical Mechanics, H. Goldstein, C. Poole, and J. Fafko, Pearson Education, Inc, 2002.
4. Mechanics, A. Sommerfeld, Academic press, 1952
5. Introduction to Dynamics, I. Perceival and D. Richaeds, Cambridge University Press, 1982.

PT-103 **Quantum Mechanics-I**

Unit –I : Revision of experimental facts leading to inadequacy of classical mechanics and need for Quantum Mechanics, Basic postulates of Wave Mechanics, Uncertainty relation in x, p, state with minimum uncertainty, Time independent and time dependent Schrodinger equation, Admissible wave function, Ehrenfest theorem, continuity equation, normalization of wave function, stationary states, application of Schrodinger equation in bound states problem: one dimensional step, well and barrier potential, harmonic oscillator, quantum mechanical tunneling.

Unit-II: General formalism of Quantum mechanics, Linear vector space, Operators in Linear space, Eigen values and Eigen vector of operators, projection operators, Hilbert space, Quantum dynamics (Schrodinger, Heisenberg and interaction picture), Vector representation of quantum theory, Coordinate , momentum and energy representation, Dirac notations.

Unit –III: Theory of angular momentum: Angular momentum operator, orbital angular momentum, spin angular momentum, Commutation relations, Eigen values and eigen vectors for L^2, L_z, Addition of angular momentum, Clebish-Gordan coefficients, Properties of CG coefficients (Orthogonality), Angular momentum and rotation, Wigner-Eckart theorem.

Unit-IV: Wave mechanics in 3-D and stationary perturbation: Motion of a free particle in spherical coordinates, Hamiltonian for a free particle in spherical coordinates, Bound states of an attractive coulomb potential, Hydrogen atom, properties of hydrogen wave functions, Stationary perturbation theory, First order correction, second order corrections, Applications to anharmonic perturbations of the form x^3 and x^4, ground state energy of He-type atoms, degenerate states, stationary perturbation theory for degenerate states, Linear stark effect and Zeeman effect in hydrogen atom.

PT-104 Basics of Electronic Devices

Unit-I

Semiconductor materials, energy bands, intrinsic and extrinsic semiconductors, intrinsic carrier concentration, Fermi energy in intrinsic and extrinsic semiconductors, temperature dependence of carrier concentration, direct and indirect bandgap semiconductors, variation of energy bands with doping

Unit-II

Carrier drift: drift velocity and mobility, electrical conductivity and resistivity, Hall-effect, carrier diffusion: diffusion process, Einstein's relation, current density equation, generation and recombination process: direct recombination, indirect recombination, surface recombination, Auger recombination, continuity equation, The Haynes –Shockley experiment

Unit-III

P-N junction, grown junction, alloyed junction, diffused junction, ion implantation, equilibrium condition of a p-n junction, contact potential, equilibrium Fermi energy level, space charge at a junction, junction and diffusion capacitance, Zener and Avalanche breakdown mechanisms

Unit-IV

Junction diodes: metal contacts, metal-semiconductor junctions, V-I characteristics, energy band diagram, Schottky barrier diode, p-n homojunctions, switching diode, breakdown diodes, varactor diode, tunnel diode, photodiode, photodetector, LED's, Electro-optic, effect, magneto-optic effect, and acousto-optic effect

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
6. Physical foundations of Solid State and Electronic Devices by Altan M. Ferendeci, McGraw-Hill, Inc.
7. Semiconductor devices- Basic Principles by Jasprit Singh
8. Physics of Semiconductor devices by S.M. Sze and Kwok K. Ng

M.Sc. Physics: II Sem.

~~Name of Specialization: Laser and Spectroscopy~~

Semester II

Common Paper-I: ATOMIC AND MOLECULAR PHYSICS

Unit-I

Quantum States hydrogen like atoms; Elementary idea of Atomic Orbitals; Angular and radial distribution functions; Parity of the wave function; Interaction of an atom with electromagnetic wave; Selection rules. Atomic spectra of hydrogen like atoms; Hydrogen fine structure. Space quantization.

Unit-II

Fine structures in alkali atoms; Electron spin, Vector atom model, Spin-orbit interaction; Equivalent and non-equivalent electrons, Pauli's exclusion principle, LS and JJ-Coupling, Breit's scheme, Spectra of alkaline earth elements; Normal and Anomalous Zeeman effect; Paschen-back effect; Stark effect. Hyperfine interaction and isotope shift; Hyperfine splitting of spectral lines; selection rules; Line broadening; Factors influencing linewidth.

Unit-III

Concept of Molecular Orbital's, Types of molecular energy states and molecular spectra, Electronic configuration of Diatomic molecules: H_2, O_2, NO and CN; Rotational spectra of diatomic molecule: Rigid and non-rigid rotator; Effect of isotopes Rotational Raman spectra; Intensity of rotational lines.

Unit-IV

Molecular vibrations: Harmonic oscillator and the anharmonic oscillator approximation, Molecular potential (Morse potential, etc.); Vibration-rotation spectra and transitions, Electronic transitions: Structure, Franck-Condon principle, Rotational structure of electronic transitions, Fortrat diagram, Dissociation energy of molecules, Continuous spectra, Raman and IR spectra.

Reference Books:

1. Introduction to Atomic Spectra: H.E. White.
2. Atomic Physic: S. N. Ghoshal
3. Atomic and Molecular Spectra: Raj Kumar
4. Molecular Spectra and Molecular Structure-I Spectra of Diatomic Molecules: G. Herzberg.
5. Physics of Atoms and Molecules: Bransden and Joachain.
6. Lasers - Theory and Applications: K. Thyagrajan and A.K. Ghatak.

Nuclear and Particle Physics (General paper for M.Sc. students)

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.

Two Nucleon Systems & Nuclear Forces: Dipole and quadrupole moments of the deuteron, Central and tensor forces, Evidence for saturation property, Neutron-proton scattering, Protonproton scattering, S-wave effective range theory. charge independence and charge symmetry , exchange character, spin dependence. General form of the nucleon-nucleon force. Isospin formalism, Yukawa interaction

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.

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, Magnetic moments and Schmidt lines,

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.

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 cheme. C, P and T invariance and application of symmetry arguments to particle reaction. Properties of quarks and their classification. Gell-Mann-Okubo mass formula for octet and decouplet, Introduction to the standard model,

M.Sc. (Physics) Second Semester

Solid State Physics (General Paper)

Unit I: Crystalline solids: Symmetry elements in 3-D, symmetry operations and group theory, point group, space group, Closed packed structures, Elastic constants and elastic waves in cubic crystals

Unit II: Absorption of X-ray, Diffraction of X-rays by lattice, Bragg's law, The Laue equation, Ewald construction, The Laue powder and rotating crystal methods. Reciprocal lattice, Brillouin zones, Crystal structure factors

Unit III: Elementary band theory, Bloch theorem, Kronig-Penney model, concept of hole, Band gaps, difference between conductors, semiconductors and insulators, intrinsic and extrinsic semiconductors, conductivity in semiconductors, mobility of carriers

Unit IV: Fermi surfaces, construction of Fermi surfaces, Effect of electric field on Fermi surface, Effect of magnetic field on Fermi surface, De Hass van alfen effect, cyclotron resonance.

1. Aschroft & Mermin : Solid State Physics,
2. C Kittel : Solid State Physics
3. M A Wahab: Solid State Physics
4. Omar: Elementary Solid State physics
5. M A Wahab: Essential of crystallography

PT-201 **Quantum Mechanics-II**

Unit –I :Approximation methods: Quasi-classical (WKB approximation), turning points, connection formulae and boundary conditions in WKB method, penetration of potential barrier using WKB method; The variational (Rayleigh-Ritz) method, application of Variational method in simple harmonic oscillator, ground state of He atom, energy and wave function of hydrogen atom.

UNIT-II: Time dependent perturbation theory: constant perturbation, harmonic perturbation, coulomb excitation, Fermi Golden rule, sudden and adiabatic approximation, Radiative transitions in atoms, Einstein's coefficients and spontaneous emission, transition probability for absorption and induced emission, electric dipole approximation, forbidden transitions, selection rules, magnetic dipole transitions

UNIT-III: Theory of scattering: Collisions in 3-D and general scattering problem, Laboratory and CM frame of references, scattering amplitude, differential scattering cross section, total scattering cross section, scattering by spherically symmetric potential, Partial wave analysis of scattering from simple potentials, scattering cross section, partial waves and phase shift, scattering by perfectly rigid spheres, scattering by square well potential.

UNIT-IV: Identical particles, symmetric and antisymmetric wave functions, collision of identical particles, spin angular momentum, many electron wave function, Hartee-Fock approach, Slater determinant, spin function for many electron system, spin and statistics.

M.Sc. Physics - III Sem.

PT-202- Statistical Mechanics

Unit-I: Laws of thermodynamics and their consequences. Thermodynamic potentials, chemical potential, Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles. distribution functions, Liouville's theorem, Law of equipartition energy, Virial theorem

Unit-II: Partition function, calculation of statistical quantities, Free energy and its connection with thermodynamic quantities. Condition for equilibrium in thermodynamics, Connection between statistics and thermodynamics, statistical equilibrium, energy and density fluctuations. Density matrix, quantum Lioville theorem, statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics,

Unit-III: Ideal Fermi and Bose gas of elementary particle, Quantum exchange effect, Degenerate electron gas, strongly Degenerate electron gas, Weakly Degenerate electron gas, Magnetism of electron gas (weak field), Relativistic electron gas, Application of Fermi statistics: White dwarf star

Unit-IV: Degenerate Bose gas, Bose-Einstein condensation, specific heat of a crystalline solid. Phase transition first and second order, Landau theory of phase transition, Ginzburg-Landau equations, Ising Problem.

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.

Introduction to Computational Physics

Unit-I : Fortran programming, flow charts, Fortran constants and variables, Type declarations, Arithmetic operators, Hierarchy, Arithmetic expressions, Logical operators and expressions, Arithmetical and assignment statements, Special functions, Input/output statements.

Unit-II : Control statements(go to, arithmetic and logical if), format specification, Logical expression, Function, Subroutines, File processing, Examples.

Unit-III : Methods for determination of zeroes of linear and non-linear algebraic equations and transcendental equations, convergence of solutions.
Solution of simultaneous linear equations, Gauss elimination method, pivoting, Iterative method, Matrix inversion.

Unit-IV: Eigenvalues and eigenvectors of matrices, Power and Jacobi method, Finite differences, interpolation with evenly spaced and unevenly spaced point, Curve fitting least square polynomial, Numerical solution of Ordinary differential equation, Euler & Runga-Kutta method, Numerical Integration, Trapezoidal rule, Simpson's rules.

TEXT AND REFERENCE BOOKS

1. Sastry: Introductory Methods of Numerical Analysis.
2. Rajaraman: Numerical Analysis.
3. J.B. Scarborough: Numerical Mathematical Analysis (Oxford and IBH)
4. Antia: Numerical methods.
5. Rajaraman: Computer programming in FORTRAN (Prentice Hall of India).
6. W.H. Press, S.A. Teakalsky, W. T. Vellerling, B. P. Flannery : Numerical Recipes in FORTRAN, Cambridge University Press.
7. Paul, L. Pavries: A first course in computational Physics, Pub. John Wiley and Sons, 1994.
8. S. Ray : A Textbook on Fortran/2003, Narosa Publishing House.

PT-303 Electrodynamics

Unit-1: Problems from Coulomb-Gauss & Maxwell law, Boundary value problems in Electrostatics- methods of images, field due to a point charge outside a plane conducting medium, field due to a point charge near a spherical conductor, Laplace's equation, separation of variables, Cartesian coordinates, spherical coordinates, boundary value problems with linear dielectrics.

Unit-2: Boundary value problems in Magnetostatics- Biot and Savart' law, differential equations of magnetostatics and Ampere's law, vector potential and magnetic induction for a circular current loop, magnetic fields of a localized current distribution, magnetic moment, macroscopic equations and methods of solving boundary value problems in magnetostatics.

Unit-3: Electromagnetic waves- Maxwell's equations, scalar and vector potentials, EM wave equations, EM waves in vacuum, linear and circular polarization, Poynting vector and Poynting theorem, refraction and reflection of EM waves at interface between two dielectrics, normal and oblique incidence, Brewester angle, total reflection, numerical problems.

Unit-4: Four dimensional Minkowski space, Lorentz transformation in 4-D space, Four vectors, Lorentz condition, vector and scalar potential, Maxwell's equations in four dimensions, retarded potential, Lienard –Wiechert potential, E and B fields due to uniformly moving charge and accelerated charge, Larmor formula, Lienard formula

Special Paper I: Advanced condensed matter physics-I (Third semester M.Sc. Physics)

Unit I: Electrons in a periodic lattice: The tight-binding method, Elementary ideas of cellular, APW, OPW and pseudo potential methods of calculating band structures.

Unit II: Many electron system: Hartree and Hartree-Fock approximations, self-consistent field method, correlation energy, dielectric screening, dielectric function of an electron gas, random phase approximation.

Unit III: Electron-electron interaction: Quasi-particle, Landau's Fermi liquid theory. Meissner effect, London equations, coherence length, cooper pairs, BCS theory of superconductivity, concept of Ginzburg-Landau theory.

Unit IV: Electron-phonon interaction: polarons, transport phenomena, onsager relations, Boltzmann transport equations and its linearlisation, relaxation time approximation, application to lattice and electronic conduction in insulators and metals.

1. Madelung : Introduction to solid state theory
2. Huang : Theoretical solid state physics
3. Kittel : Quantum theory of solids.
4. Verma & Srivastave : Crystallogrphy for solid state physics
5. Kittel : Solid state physics
6. Aschroft & Mermin : Solid State Physics,
7. M A Wahab: Solid State Physics
8. Omar: Elementary Solid State physics
9. Ziman: Electrons and Phonons

Paper I: Nuclear Structure

Semi-empirical mass formula, Liquid Drop Model for spherical and Deformed Nuclei

Nuclear Shell Model:

Shell model: Review of the Shell Model, magic numbers, single particle shell model, wave function, quantum numbers, Residual interaction and configuration mixing, effective interaction and operators, Description of two or more particles outside a closed core. Classification of shells, Seniority, Pairing force, Energy level calculations. Spectra of closed shell nuclei, lp-lh excitations

Collective models:

Nuclear vibrations and excited states, isoscalar vibrations, sum rule in vibration model, Collective model of Bohr and Mottelson, Energy levels and electromagnetic properties of even-even and odd-A deformed nuclei, Permanent deformation, Nuclear shapes, super deformed and hyper deformed shapes. Particle states in nonspherical nuclei-Nilsson's model, Coupling of particle states and collective motion in unified model, Behavior of nuclei at high spin state, Qualitative discussion and estimates of transit ion rates, Nuclear moment of inertia, Back bending,

Shell Corrections and the Strutinsky Method, Cranking Model

Mean Field models:

Nuclear mean field, Hartree-Fock theory, Hartree-fock Bogolieubov, Pairing plus quadrupole interactions.

Exotic Nuclei:

Nuclear landscape: proton and neutron drip lines, nuclear structure at the extremes of stability, nuclear halos, neutron skins, proton rich nuclei and beyond, decay modes of exotic nuclei, Production of exotic nuclei – RIB and ISOL facility (an overview)

M.Sc. (Physics)

Semester - III

__Special Paper:__ Astronomy & Astrophysics - I

Unit – I

Celestial Sphere, Stellar Parallax, Units of Stellar Distance, Stellar Magnitude Sequence, Apparent and Absolute Magnitudes, Distance Modulus, Stellar distances, Bolometric Magnitude, Color index, Luminosities of Stars, Spectral classification, Henry-Draper and Modern M-K Classification Scheme, H-R diagram of Stars, Empirical Mass-Luminosity Relation.
Stellar Interiors: The Basic Equations of Stellar Structure, Hydrostatic Equilibrium, Thermal equilibrium, Virial Theorem, Energy Eources, Energy Transport by Radiation and Convection, Equation of State

Unit – II

Formation and Evolution of Stars: Inter stellar Dust and Gas, Formation of Proto-stars, Pre-main sequence evolution, Evolution on the Main Sequence for Low and High Mass Stars, Post Main Sequence Evolution, End States of Stars, Degenerate States, White Dwarf and Chandrasekhar Limit, Fate of Massive Stars, Neutron Stars, Pulsars and Black Holes, Supernovae and its Characteristics.

Unit – III

Binary Stars and their Classification, Close Binaries, Roche Lobes, Evolution of Semidetached Systems: Algols, Cataclysmic Variables and X-Ray Binaries.
Star Clusters: Galactic Clusters, Globular Clusters, H-R diagram of Star Clusters

Unit – IV

Astronomical Instrumentations: Telescopes – Basic Optics, Focal Plane, Plate Scale, Resolution and Rayleigh Criterion, Seeing, Aberrations, Brightness of an Image, Refracting Telescopes, Reflecting Telescopes, Telescope Mounts, Large-Aperture Telescopes, Adaptive Optics, Space-Based Observatories, Telescopes for Infrared, Ultraviolet, X-Ray, Gamma-Ray and Radio Astronomy, Stellar Photometry using CCD.

TEXT AND REFERENCE BOOKS:

1. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey publishing Co.
2. The Physical Universe: An Introduction to Astronomy, F. Shu, Mill Valley: University Science Books.
3. Universe, R.A. Freedman and W.J. Kaufmann, W.H. Freeman & Co.
4. Fundamental of Astronomy, H. Karttunen et al., Springer.
5. The Physics of Stars, A.C. Phillips, John Wiley & Sons, Ltd.
6. An Introduction to Astrophysics, Baidyanath Basu, Prentice Hall of India.
7. Textbook of Astronomy and Astrophysics with Elements of Cosmology, V.B. Bhatia, Pb - New Delhi, Narosa Publishing House.
8. Theoretical Astrophysics, Vol. I: Astrophysical processes T. Padmanabhan, Cambridge University Press.
9. Theoretical Astrophysics, Vol. – II: Stars and Stellar Systems, T. Padmanabhan, Cambridge University Press.
10. Introductory Astronomy and Astrophysics, M.Zeilik and S.A. Gregory, 4th edition, Saunders College Publishing.
11. The New Cosmos, A. Unsold and B. Baschek, Newyork, Springer Velas.
12. Astronomical Photometry, A.A. Henden, and R.H. Kaitchuk, Willmann-Bell.
13. Handbook of CCD Astronomy, S.B. Howell, Cambridge University Press.
14. A Workbook for Astronomy, Jerry Waxman
15. Telescope and Techniques, C.R. Kitchin, Springer.
16. Astrophysical Techniques, C.R. Kitchin, CRC Press.
17. Observational Astrophysics, R.C. Smith, Cambridge University Press.
18. Telescopes and Techniques, C.R. Kitchin , Springer.
19. Observational Astronomy, D.S. Binney, G. Gonzalez, and D. Oesper, Cambridge University Press

M.Sc. (Physics)

Semester - III

Special Paper Lab: Astronomy & Astrophysics

1. Study of Quasar.
2. Study of the Orbit of a Visual Binary Star.
3. Determine the Mass of Saturn and its Rotational Velocity.
4. Verification of Hubble's law and Determination of Hubble 's Constant and Age of the Universe.
5. Study of Light Curves of Cepheid Variable Stars.
6. Study of Proper Motion of Stars.
7. Determination of Period and Distance of Pulsar.
8. Photo-electric Photometry of Pleiades Star Cluster.
9. Study of Expansion of the Universe and Calculate the Age of the Universe using Computer Programme 'CLEA'.
10. Determine the distance of Small Magellanic Cloud (SMC) using Period-Luminosity Relation of Cepheid Variable Star.

Semester III

Special Paper-I: MOLECULAR SPECTROSCOPY

Unit-I

Classification of molecule: Linear, Symmetric top, Asymmetric top and Spherical top; Rotational Energy of Spherical, Prolate and Oblate Symmetric Rotors, Rotational Raman Spectra; Parallel and Perpendicular type Bands in Linear and symmetric Rotor Molecules. Qualitative description of Type A, B and C bands in Asymmetric Rotor Molecules.

Unit-II

Molecular orbitals, Separation of electronic and nuclear wavefunctions, Born-Oppenheimer approximation, Electronic states of diatomic molecules, Electronic angular momenta, Approximation methods for the calculation of electronic Wave function, The LCAO approach, Coulomb, Exchange and Overlap integral, Symmetries of electronic wavefunctions; Shapes of molecular orbital; σ and π bond; Term symbol for simple molecules.

Unit-III

UV-visible absorption spectroscopy: Principle, Lambert-Beer's law, Absorption law, Deviation from Beer's law, Instrumentation. Single beam and split beam instruments. Quantitative & Quantitative and Analysis of absorption spectra, Molecular transitions, Luminescence spectroscopy (fluorescence, phosphorescence, chemiluminescence)

Unit-IV

Infrared Spectroscopy: Theory and Instrumentation of dispersive and FT-IR spectroscopy, Raman Spectroscopy: Theory and Instrumentation; Spectra-Structure Correlations in Raman Spectroscopy; Electron Spin Resonance (ESR) Spectroscopy; Nuclear Magnetic Resonance (NMR) spectroscopy, Chemical shift; shielding and deshielding of protons, Nuclear spin spin interaction.

Reference Books:

1. Fundamentals of Molecular Spectroscopy: C.N. Banwell.
2. Molecular Spectra and Molecular Structure-III Electronic Spectra and Electronic structure of polyatomic Molecules: G. Herzberg.
3. Modern Spectroscopy: J.M. Hollas.
4. Introduction to Molecular Spectroscopy: G.M. Barrow.
5. Chemical Applications of Group Theory : F.A. Cotton.

SPECTROSCOPY LABORATORY

1. Verification of Hartmann formula for prism spectrogram
2. Rydberg's constant using constant deviation prism.
3. Coherence & width of spectral lines using Michelson interferometer.
4. Wavelength determination of alkali atom.
5. Determine the spot size and hence the divergence of given He-Ne laser
6. Estimate the diameter of the given wires using He-Ne laser
7. Determine some of the vibrational bands of the given sample (HDPE) using the IR spectrophotometer. Determine the force constant for the C-C, C-H bonds.
8. Determination of Brewster Angle and estimation of refractive index of the given transparent material
9. Power distribution within the He-Ne beam
10. Measurement of Raman spectrum of CCl_4.

Similar experiments will also be thought of from time to time.

M.Sc. III Semester Physics
Advanced Plasma Physics-I

Unit-1:

Production of Plasma in the laboratory. Physics of glow discharge, electron emission, ionization, breakdown of gases, Paschen's laws and different regimes of E/p in a discharge, Townsend discharge and the evolution of a discharge.

Plasma diagnostics: Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts.

Unit-2:

Fluid description of plasmas: distribution functions and Liouville's equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations.

Waves in fluid plasmas: dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion-acoustic waves, Alfven waves, Magnetosonic waves.

Unit-3:

Stability of fluid plasma.: The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of alfven waves, Plasma supported against gravity by magnetic field, energy principle.

Kinetic description of plasma: microscopic equations for may body systems: Statistical equations for a many body system, Vlasov equation and its properties, drift kinetic equation and its properties.

Unit-4:

Waves in Vlasov Plasma: Vlasov equation and its Linearlization, solutions of linearised Vlasov equation, theories of Langumuir waves, Landau damping, Ion Acoustic waves, Drift waves in magnetized plasmas.

Non-linear plasma theories: Non linear electrostatic waves, solitons, shocks, non linear Landau Damping.

Thermonuclear fusion: Status, problems and technological requirements.

Applications of cold low pressure and thermal plasmas

Text & Reference Books:

[1] J. A. Bittencourt, Fundamentals of Plasma Physics, Pergamon Press
[2] N. A. Krall and A. W. Trivelpiece, Principle of Plasma Physics, McGraw Hill
[3] F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Plenum Press
[4] P. M. Bellan, Fundamentals of Plasma Physics, Cambridge University Press
[5] J. P. Goedbloed and S. Poedts, Principles of Magnetohydrodynamics, Cambridge Press

Material Science -I

Laws of thermodynamics, Thermodynamic functions, Concept of free energy, Stability and metastability, Relative stability of phases, Phase rule and phase diagrams, Solid solutions, Limited and unlimited solid solubility, interstitial and substitutional solid solutions, Hume Rothery rules, Uniary (single component) and Binary phase diagrams (Lead - tin and Iron-carbon phase diagram), Lever rule, Homogeneous and heterogeneous nucleation, growth and transformation kinetics, Micro-structural changes during cooling and heating.

Preparation of bulk, thin film and nano-materials: Solid state reactions method, sol-gel method, precipitation method. Nanomaterials: Bottom up method: Cluster beam evaporation, Ion beam deposition, Chemical bath deposition; Top down method:Ball Milling, Lithography. Advantages and disadvantages of various synthesis methods.

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 , Introduction to liquid crystalline materials, Mechanism of liquid crystal display devices,

Introduction to Dielectric, magnetic and multiferroic materials: Dielectric materials, linear and non-linear dielectrics, Ferro-electric materials, Important characteristics and applications of ferro-electric materials, Para, ferro, anti-ferro magnetic properties of materials, hysteresis losses, hard and soft magnetic materials, Structure and properties of spinals, garnets and hexagonal ferrites, and their uses. 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. Wulf
4. Jain K.P., Physics of Semiconductor Nanostructures, Narosa Publishing House (1997).
5. Cao, G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Emperial College Press (2004).

M.Sc. (Physics): Experimental Techniques in Physics

Unit – I

Signal processing techniques: pre-amplifiers, filters; Measurement techniques: sensors and transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical detectors), general instrumentation, Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback),

Unit – II

Filtering and noise reduction, shielding and grounding, lock-in detector, box-car integrator, modulation techniques, High frequency devices (including generators and detectors), Rotary vane pump, Roots blower pump, Diffusion pump, Ionization pump, Diaphragm pump, Adsorption pump, Turbo molecular pump; Measurement of Vacuum: Pirani/Thermocouple gauge, Penning/Ionization Gauge (hot cathode and cold cathode), Leak detection.

Unit – III

Production, properties and applications of x-rays, x-ray absorption and its roll in structure evaluation, x-ray detectors, real and reciprocal space, Introduction x-ray techniques: Introduction to small Angle X-ray Scattering (SAXS), x-ray fluorescence (XRF), energy dispersive x-ray (EDX), particle induced x-ray emission (PIXE) and their applications, Neutron diffraction, Small Angle Neutron Scattering (SANS),

Unit – IV

Surface morphology using Transmission electron microscopy (TEM), Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM). Depth profiling by ion beam sputtering and Secondary ion mass spectrometry (SIMS), Low energy ion scattering (LEIS), Introduction to Rutherford Back Scattering Spectrometry (RBS),

TEXT AND REFERENCE BOOKS

1. Analog and Digital Electronics for Scientists (2nd Ed.) (Wiley – Inter-science, New York).
2. Surface Analysis Methods in Materials Science : D. J. O. Conner (Springer Verlag).
3. Characterization of Solid Surface: P.F. Kane (Plenum).
4. R. Sahu, *Physics of solid, nuclei and particle*, Narosa publishing house, 2006.
5. K. L. Chopra, *Thin film phenomena* , Mcgraw- Hill book company latest Edition.
6. C. C Julian, *Introduction of electron Scanning Tunneling Microscopy*, Coulombia university press, 2006
7. V. V. Rao, T. B. Ghosh and K. L. Chopra, Vacuum Science and Technology, Allied Publishers – 1998.
8. N. Harris, Modern Vacuum Practice [Freely available on net] (www.modernvacuumpractice.com/editor/user_DocView.asp?DocumentID=18)
9. D. M. Hoffman, B. Singh & J. H. Thomas, Handbook of Vacuum Science and technology, Academic press: 2005.
10. J. M. Lafferty, Foundations of Vacuum science and Technology, John Wiley and Sons, New York, 1998.
11. A. Chambers, R. K. Fitch & B. S. Halliday, Basic Vacuum technology, 2nd Ed, Overseas press, New Delhi - 2005 or CRC press – 1998.
12. J. A. Nielson and D. Mc Morrow, Elements of Modern X-ray physics, John Wiley & sons, 2001.
13. G. V. Pavlinsky, Fundamentals of x-ray physics, Cambridge International sci Pub, 2008.
14. A. K. Singh, Advanced X-ray Techniques in Research and Industry, Capital Publishing Company, 2006.
15. N. Kasai, M. Kakudo, X-ray diffraction by macromolecules, Springer, 2005.

Mr. C. Mallik (CM)
Dr. S. P. Patel (SPP)

M.Sc. (Physics): Accelerator Physics

UNIT-I

History of Accelerators, Livingston plots, achievements of Accelerators, Brief descriptions of Accelerators centers worldwide, Accelerator Centers in India,

Motion of charge particle in electric and magnetic field, Hamiltonian for particle motion Accelerator, Linear betatron motion, Particle motion dipole and quadrupole, Liouville's theorems, Emittance, Brightness

DC Accelerators: Cockroft-Walton, Van-de-Graaff, Tandem and Pelletron Accelerator, DC accelerators in India, Bilaspur accelerator.

UNIT-II

Circular Accelerator: Syncrotron, Longitudinal equation of motion, evolution of synchrotron phase space ellipse, Injection & extraction, CAT indore synchrotron

Circular accelerator: Simple cyclotron, development of AVF cyclotron, Superconducting accelerators, Cyclotrons in India, colliders and storage

UNIT-III

Linear Accelerator: Historical Milestone, Fundamental properties of accelerator structure; transit time, shunt impedance , Particle Accelerator by EM waves, Longitudinal particle dynamics in LINAC, Transversal beam dynamics in LINAC, Druft tube Linac, Radio Frequency Quadrupole, Superconductivity in Accelerators, Superconducting magnets, Superconducting Radio Frequency system.

UNIT-IV

Production of charged particles, space charges limitation; n-tou product, Extraction & focussing geometries, positive ion sources; penning ionization source, ECR source, Electron beam ion source, negative ion sources; SNICS, TORVIS, duo-plasmatron.

Beam optics; Transfer matrix method, dipole, quadrupole, sextupole, octupole, Einzel lens, solenoid, beam analysers, steerer, beam line components.

Applications; Solid State physics & materials science, Nuclear physics, high energy particle physics, industrial applications, medical applications

Semester IV

Common Paper: Molecular Physics and Group Theory

Unit-I

Vibrations in polyatomic molecules; Normal coordinates and normal modes; Overtone and Combination Bands Normal Coordinate Analysis; Symmetry properties of Normal coordinates; Vibrational Intensities: Interpretation and Use for Diagnostic Purposes;

Unit-II

Group Theory: Definition and theorem of group theory, Properties of groups, sub-groups and classes; Molecular symmetry; Symmetry elements and operations; Symmetry planes and reflections; Proper and improper rotations; Product of symmetry operations; Effects of Symmetry Lowering on Vibrational Spectra.

Unit-III

Representation of point group; Matrix representation of the symmetry elements of a point group. Great Orthogonality Theorem; Character tables; Reducible and irreducible representations; Symmetry species; Character tables for point groups.

Unit-IV

Application of group theory to molecular vibration. Analysis of reducible representation; characters for the reducible representation of molecular motions; number of normal modes of various symmetry types.

Reference Books :

1. Chemical Applications of Group Theory : F.A. Cotton.
2. Introduction to Molecular Spectroscopy: G.M. Barrow.

M.Sc. Physics: Fourth Semester

Special Paper II: Advanced condensed matter physics-II

Unit I: Reconstruction and relaxation phenomena, work function, thermionic emission, electronic surface states, magnetoresistence. Disorder in condensed matter, substitutional, positional and topographical disorder, short and long range order.

Unit II: Atomic correlation function, Anderson model for random systems and electron localization, mobility edge, qualitative application of the idea to amorphous semiconductors and hopping conduction.

Unit III: Quantum theory of magnetic susceptibility, Pauli paramagnetism, magnetic properties of two-electron system, spin Hamiltonian and Heisenberg model, magnetic interaction in free electron gas, mean field theory, Exchange interaction, one-and two-dimensional ising model, spin waves, magnons.

Unit IV: Electron-photon interaction: Optical reflectance, Excitons, Kramers-kronig relations, Electronic inter-band transitions.

1. Madelung : Introduction to solid state theory
2. Huang : Theoretical solid state physics
3. Kittel : Quantum theory of solids.
4. Verma & Srivastave : Crystallogrphy for solid state physics
5. Kittel : Solid state physics
6. Aschroft & Mermin : Solid State Physics,
7. M A Wahab: Solid State Physics
8. Omar: Elementary Solid State physics
9. Ziman: Electrons and Phonons

Paper II: Measurement Techniques and Nuclear Reaction

Measurements Techniques and Data Processing:

Interaction of charged particles and radiation with matter, Simplified detector model , Detection technique, detector characteristics (sensitivity, response, efficiency, dead time), Ionizing Radiations, gas detectors, Scintillation counters : Organic and inorganic scintillators - Theory, characteristics and detection efficiency Solid state detectors: semiconductor detectors, surface barrier detectors, experimental techniques in particle and gamma ray spectroscopy, gamma detector arrays, coincidence method, decay schemes, Lifetime measurements: Electronic method, Doppler shift based techniques

Nuclear Electronics:

Analog and digital pulses, Signal pulses, Transient effects in an R-C Circuit, Pulse shaping, Linear amplifiers, Pulse height discriminators, General characteristics of single & multi-channel methods, Introduction to data acquisition system (MCA,CAMAC and VME).

Nuclear Reaction:

Classification of nuclear reactions – Direct and Compound nuclear reaction mechanisms, Discussion of Compound nucleus model, Resonance, level density, decay, cross-section, entrance channel effect, Statistical model, Pre-equilibrium model, Direct reactions: elastic and inelastic scattering, examples of direct reactions, nuclear spectroscopy from direct reactions. Concept of Optical Model, Rearrangement collision: DWBA approach.

Heavy ion induced nuclear reactions

Heavy ion reactions (Semiclassical approach), Elastic scattering, Coulomb excitation, Deep inelastic collisions, Fusion, Fission, Coulomb excitation and its applications. Spontaneous fission, Mass energy distribution of fission fragments.

M.Sc. (Physics)

Semester – IV

Special Paper: Astronomy & Astrophysics - II

Unit– I:

Variable Stars: Classification of Variable Stars, Cepheid Variables, Period-Luminosity Relations of Cepheid Variables, RV Tauri Variables, Mira Variables, Red Irregular and Semi-regular Variables, Beta Canis Major Variables, U Geminorum and Flare Stars, Pulsation theory of Variable Stars.

Unit- II:

The Milkyway Galaxy: Structure of the Milkyway, Oort's Theory of Galactic Rotation, Dynamics of the Spiral Arms, Distribution of Interstellar matter, Central regions of the Milkyway.

Normal Galaxies: Classification of galaxies, Hubble Sequence: Elliptical, Lenticulars and Spiral Galaxies, and Their Properties, Distribution of Light and Mass in Galaxies, Brightness Profiles, Distribution of Gas and Dust in Galaxies.

Unit- III:

Active galaxies: Active Galactic Nuclei (AGNs), Seyfert galaxies, BL Lac Objects, LINERs, and Radio Galaxies: General Properties, Superluminal motion, Quasars: Properties and Energy Requirements, Nature of Quasar redshifts, Supermassive Black Hole Model and Unified model of AGNs.

Unit- IV:

Cosmology: Cosmological Principle, Robertson-Walker Line Element, Cosmological Red shift, Hubble's Law, Models of the Universe, Friedman Models, Density Evolution, Critical Density, Models with the Cosmological Constant, Observable Quantities – Luminosity and Angular Diameter Distances, Red shift- Magnitude Relation, Steady State Cosmology.

Relics of the Big Bang, Early Universe, Thermodynamics of the Early Universe, Primordial Neutrinos, Helium Synthesis and Other Nuclei, Cosmic Microwave Background (CMB).

TEXT AND REFERENCE BOOKS

1. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey publishing Co.
2. The Physical Universe: An Introduction to Astronomy, F. Shu, Mill Valley: University Science Books.
3. Universe, R.A. Freedman and W.J. Kaufmann, W.H. Freeman & Co.
4. Fundamental of Astronomy, H. Karttunen et al., Springer.
5. The Physics of Stars, A.C. Phillips, John Wiley & Sons, Ltd.
6. An Introduction to Astrophysics, Baidyanath Basu, Prentice Hall of India.
7. Textbook of-Astronomy and Astrophysics with Elements of Cosmology, V.B. Bhatia, Pb - New Delhi, Narosa Publishing House.
8. Theoretical Astrophysics, Vol. I: Astrophysical processes T. Padmanabhan, Cambridge University Press.
9. Theoretical Astrophysics, Vol. – II: Stars and Stellar Systems, T. Padmanabhan, Cambridge University Press.
10. Theoretical Astrophysics, Vol. – III: Galaxies and Cosmology, T. Padmanabhan, Cambridge University Press.
11. Introductory Astronomy and Astrophysics, M.Zeilik and S.A. Gregory, 4th edition, Saunders College Publishing.
12. The New Cosmos, A. Unsold and B. Baschek, Newyork, Springer Velas.
13. Galactic Astronomy, J. Binney and M. Merrifield, Princeton University Press.
14. Galactic Dynamics, J. Binney and S. Tremaine, Princeton University Press.
15. An Introduction to Active Galactic Nuclei, B.M. Peterson, Cambridge University Press.
16. Quasars and Active Galactic Nuclei, A.K. Kembhavi and J.V. Narlikar, Cambridge University Press.
17. Introduction to Cosmology, J.V. Narlikar, 3 rd edition, Cambridge University Press.
18. General relativity and Cosmology, J.V. Narlikar-Delhi: Macmillan Company of India Ltd.
19. Structure Formation in the Universe, T.Padmanbhan, Cambridge University Press.

Semester IV

Special Paper-II: ADVANCE SPECTROSCOPY

Unit-I

Properties of Laser Beams; Pumping Schemes; Threshold pump power, Optical resonators, Stability of resonators, Role of Plane and Confocal cavity resonators, Mode selection, Generation of Ultra short Pulses; Characteristics of Gaussian beam, Transverse and longitudinal modes, mode selection, losses in a resonator, mirror mounts, optical coating etc., Q-switching and Mode locking;

Unit-II

Types of Lasers: Solid-State, Dye, and Semiconductor Lasers; Laser Tuning; Reasons for Multimode Oscillation; Single-Mode Selection; Non-linear polarization of lasers and some applications: Second harmonic generation using non-linear optical methods.

Unit-III

Spectrograph and Monochromator, Interferometer, Comparisons between spectrometers and Interferometers; Detectors: Photomultiplier tube (PMT), Charge coupled detectors (CCD), Thermal detectors; Dispersion and Resolving power of prism and gating instruments;

Unit-IV

Non-linear Spectroscopy: linear and non-linear absorption; Two photon absorption, Stimulated Raman Scattering; Coherent Anti-Stokes Raman Scattering
Special Techniques: Resonance Raman Spectroscopy; Surface Enhanced Raman Spectroscopy; Time-resolved 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

Advanced

Special Paper: Plasma Physics – II

Unit-I: Fluid Theories in Plasmas

Single fluid and two fluid theories, Magnetohydrodynamic (MHD) fluid theory, Flux freezing, Fast, Slow and Intermediate MHD waves, Friedricks diagram, Magnetic viscosity, Reynolds number, Ideal MHD, Dissipation in MHD fluid, Collisonless anisotropic plasma, Chew-Goldberger and Low (CGL) theory.

Unit-II: Nonlinear Phenomenon

Concept of Sheath, Wave-particle interaction, Wave-wave interaction, Mode decay, Nonlinear Landau damping, Wave kinetic equation, KDV equations, Vortices formation, Shock wave formation, MHD turbulence

Unit-III: Instabilities in Plasmas

Stable, Neutral and unstable systems, Analysis of stability and instability, Kinetic theory, Macroinstabilities, Self-gravitational instability, Rayleigh-Taylor (R-T) instability, Kelvin-Helmholtz (K-H) instability, Structure formation, Microinstabilities, Electron cyclotron instability, Two-stream instability

Unit-IV: Basics of Dusty (Complex) Plasmas

Dusty plasma and parameters, Characteristics of complex plasma, Applications, Dust charging process, Dynamics of dust grain, Strong coupling phenomenon, Complex plasma crystal formation, Waves in dusty plasma, Polarization phenomenon in dusty plasma, Diploe-dipole interaction, Shadowing force.

Text & Reference Books:

[1] J. A. Bittencourt, Fundamentals of Plasma Physics, Pergamon Press
[2] N. A. Krall and A. W. Trivelpiece, Principle of Plasma Physics, McGraw Hill
[3] F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Plenum Press
[4] P. M. Bellan, Fundamentals of Plasma Physics, Cambridge University Press
[5] P. K. Shukla and A. A. Mamun, Introduction to Dusty Plasma Physics, IOP
[6] J. P. Goedbloed and S. Poedts, Principles of Magnetohydrodynamics, Cambridge Press
[7] L. D. Landau and E. M. Lifshiz, Statistical Physics
[8] S. Chandrasekhar, Hydrodynamic and Hydromagnetic Stability, Clarendon Press

Materials Science-II

Elementary idea of Advanced materials: General features and classifications, Structure models for amorphous materials, Structure and properties of metallic glass and amorphous semiconductors, Quasicrystalline materials, Materials for solar cell applications, Hydride materials (Hydrogen storage materials), Materials for Sensors and transducers application,

Materials Characterization techniques: X- ray diffaction methods for materials characterisation, powder diffraction methods, Indexing of powder diffraction patterns, Determination of particle size, Increase in x-ray diffraction peaks of nanoparticles, Shift in photo luminescence peaks, Raman and FTIR spectroscopy of materials, Photoemission microscopy,

Light / Optical Microscopy: Optical microscope- Basic principles & components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Electron Microscope and its applications in materials characterisation.Principle of Scanning Electron Microscope, study of microstructure, determination of grain size etc, Advantages of Neutron diffraction.

Thermal Analysis: Thermal analysis,Thermogravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermomechanical analysis and dilatometry,

Book Recommended:

1. Introduct ion to solid state physics : C.Kittel
2. Superconduct ivity Today : T.V. Ramkr ishnan and C.V. R.R
3. Raghvan, V., Materials Science & Engineering, PHI (1998).
4. Callister, W.D., Materials Science & Engineering: An Introduction, Wiley & Sons (2001).
5. Smith, W., Principles of Materials Science and Engineering., McGraw Hill (1990).
6. Cao, G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Emperial College Press (2004).