M.Sc. PHYSICS

COURSE STRUCTURE AND SCHEME OF THE PROGRAMME

DEPARTMENT OF PHYSICS
DR B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY
JALANDHAR – 144011

PREFACE

Department of Physics was established in the year 1989, in the very first year of inceptions of the then “Dr. B.R. Ambedkar Regional Engineering College, Jalandhar”, to provide the basic Physics inputs to the B.Tech students of all the disciplines. M.Tech (Part-Time) in Material Science and Technology was also started in the year 2001. With up gradations of Regional Engineering College, Jalandhar to National Institute of Technology, Jalandhar (Deemed University), the courses offered to B.Tech/M.Tech programmes were revised in accordance with the stipulations made in National Institute of Technology, rules, 2002.

Department has started M.Sc. Physics Programme from the academic session i.e. Aug 2006-2007. The special feature of M.Sc.Programme will be to provide M.Sc. degree to the students with specialization in Plasma Physics. We know that plasma find applications in many diverse fields like space, controlled thermonuclear fusion, plasma processing (thin film deposition, plasma based lighting, plasma chemistry, plasma spray), environment and health science, material synthesis (nanotechnology), switches, relays, antennas, power systems, waste processing etc. We also know that products manufactured using plasma technologies are computer chips and integrated circuits, computer hard drives, machine tools, medical implants and prosthetics, audio and video tapes, aircraft and automobile engine parts, printing on plastic food containers, energy-efficient window coatings, safe drinking water, voice and data communications components, anti-scratch and antiglare coatings on eyeglasses etc. Further Plasma related experiments are excellent vehicles for illustrating and understanding complex physical concepts and for exploring cutting-edge topics in physics, Materials Sciences, Computer Sciences and Mathematics. It is clear that plasma science and technology encompass immense diversity, pervasiveness and potential. Already plasma technologies have a significant contribution in the industry, with the annual world market size approaching $ 200 billion. Consensus has already emerged among the scientific community that plasma-based technology would be the most dominant technology in the 21st century because plasma assisted devices are more efficient. Keeping in view the importance of Plasma Science and Technology the Department of Physics has adopted Plasma Physics as the thrust area of the department to train the students as better professionals & researchers in the field.

(Dr. Rohit Mehra)
Chairman, Board of Studies
Dr. B.R. Ambedkar
National Institute of Technology
Jalandhar – 144011

08.04.2016

Course Structure and Scheme of the Programme

M.Sc. Physics

SEMESTER I

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PH-511	Classical Mechanics	3	1	-	3	4
2.	PH-512	Mathematical Physics	3	1	-	3	4
3.	PH-513	Electronics	3	1	-	3	4
4.	PH-514	Computational Techniques	3	1	-	3	4
5.	PH-541	Electronics Lab.	-	-	6	3	3
6.	PH-542	Computer Lab.	-	-	6	3	3
Total Credits in First Semester							22

SEMESTER II

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PH-515	Quantum Mechanics-I	3	1	-	3	4
2.	PH-516	Solid State Physics-I	3	1	-	3	4
3.	PH-524	Statistical Physics	3	1	-	3	4
4.	PH-518	Electrodynamics	3	1	-	3	4
5.		Elective-I	3	-	-	3	3
6.	PH-543	Solid State Physics Lab.	-	-	6	3	3
Total Credits in Second Semester							22

SEMESTER III

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PH-519	Quantum Mechanics-II	3	1	-	3	4
2.	PH-520	Solid State Physics-II	3	1	-	3	4
3.	PH-521	Plasma Physics	3	1	-	3	4
4.	PH-522	Nuclear Physics	3	1	-	3	4
5.	PH-545	Nuclear Physics Lab.	-	-	6	3	3
6.	PH-546	Plasma Lab.	-	-	6	3	3
Total Credits in Third Semester							22

SEMESTER IV

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PH-523	Particle Physics	3	1	-	3	4
2.	PH-517	Atomic and Molecular Spectroscopy	3	1	-	3	4
3.		Elective -II	3	-	-	3	3
4.	PH-544	Spectroscopy Lab.	-	-	6	3	3
5.	PH-561	Project	-	-	-	-	10
Total Credits in Fourth Semester							24

List of Electives - I

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PH- 535	Digital Electronics	3	0	-	3	3
2.	PH- 536	Nuclear Instrumentation	3	0	-	3	3
3.	PH-540	Polymer & Liquid Crystals	3	0	-	3	3
4.	PH-538	Nanostructured Materials	3	0	-	3	3
5.	PH-539	Experimental Techniques in Physics	3	0	-	3	3

List of Electives - II

S.No.	Course Code	Course Title	Teaching Schedule			Duration of Exam. (hr.)	No. of Credit
			Lecture	Tutorial	Practical		
1.	PH-531	Nuclear Accelerator and Radiation Physics	3	0	-	3	3
2.	PH-532	Opto Electronics	3	0	-	3	3
3.	PH-533	Microwaves	3	0	-	3	3
4.	PH-537	Quantum Field Theory	3	0	-	3	3
5.	PH-534	Physics of Polymers	3	0	-	3	3

PH-511 Classical Mechanics [3-1-0]

Lagrangian Mechanics: Newton's laws of motion, mechanics of a system of particles, constrain, D'Alembert's principle and Lagrange equations of motion. Velocity dependent potentials and dissipation function. Some applications of Lagrangian formulation, Hamilton's principle, derivation of Lagrange equations from the Hamilton's principle. Conservation theorems and symmetry properties.

Central Force Problem : Two body central force problem, reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one dimensional problem and classification of orbits. The differential equation for the orbit and integrable power-law potential. The Kepler problem. Scattering in a central force.

Rigid Body Dynamics: The independent coordinates of a rigid body, orthogonal transformations, the Euler's angles. Euler's theorem on the motion of rigid body, finite and infinitesimal rotations, rate of angular momentum and kinetic energy about a point for a rigid body, the inertia tensor and moment of inertia, the eigenvalues of moment of the inertia tensor and the principal axes transformation. Euler's equations of motion, torque free motion of a rigid body.

Canonical Transformations and Hamilton-Jacobi Theory: Legendre transformation and Hamilton's equations of motion, cyclic coordinates and conservation theorems, derivation of Hamilton's equations from a variational principle, the principle of least action. The equation of canonical transformations, examples of canonical transformations, Poisson brackets. Equations of motion, infinitesimal canonical transformation and conservation theorems in the Poisson bracket formulation. The Hamilton-Jacobi equation for Hamilton's Principal Function, The harmonic Oscillator Problem as an example of the Hamilton-Jacobi method.

Books Recommended:

1. Goldstein H "Classical Mechanics", Narosa Publishing House, New Delhi, (2004).
2. Landau L D and Lifshitz E M "Mechanics", Pergamon Press, Oxford, (1989).
3. Aruldhas G "Classical Mechanics", PHI Learning Pvt. Ltd., Delhi, (2013).
4. Rana N C and Joag P S "Classical Mechanics", Tata McGraw-Hill Publishing Co., New Delhi.
5. Shankara Rao "Classical Mechanics", Prentice Hall of India, New Delhi, (2005).

PH-512 Mathematical Physics [3-1-0]

Vector Calculus & Tensors: Curvilinear coordinates, differential vector operators in curvilinear coordinates, spherical and cylindrical systems, general coordinate transformation, tensors; covariant, contravariant and mixed, algebraic operations on tensors.

Complex Analysis: The Cauchy-Riemann conditions, Cauchy integral theorem, Cauchy integral formula, Taylor and Laurent series, singularities and residues, Cauchy residue theorem, Calculation of real integrals.

Laplace transforms: Definitions, Conditions of existence, functions of exponential orders, Laplace transform of elementary functions, Basic theorems of Laplace transforms, Laplace transform of special functions, Inverse Laplace transforms, its properties and related theorems, convolution theorem, use of Laplace transforms in the solution of deferential equation with constant and variable coefficients and simultaneous differential equations.

Fourier Transformation: Fourier decomposition, Fourier series, and convolution theorem. Fourier transformations and its application to wave theory.

Differential Equations: Second order differential equation, Frobenius method, Wronskian and a second solution, The Sturm Lioville problem, One dimensional Green's functions, Partial differential equation, Laplace equation, Possion equation, Boundary value problem.

Special Functions: Gamma function, the exponential integral and related functions, Bessel functions of the first and second kind, Legendre polynomials, associated legendre polynomials and spherical harmonics, Generating functions for Bessel, legendre and associated legendre functions.

Group Theory: Definition of a group, Multiplication table, Conjugate elements and classes of groups, directs product, Isomorphism, homeomorphism, permutation group, Definitions of the three dimensional rotation group and SU(2).

Books Recommended:

1. George Arfken " Mathematical Methods for Physists", Academic Press, San Diego, U.S.A
2. Harvil and Pipes L.A "Mathematical Methods for Physicists and Engineers" Tata McGraw-Hill Publishing Company, New Delhi, 1958.
3. Rajput B.S. "Mathematical Physics" Pragati Prakashan, Meerut, 2005.
4. Speigal M.R. "Laplace Transforms", Schaum Series Tata McGraw-Hill Publishing Company, New Delhi, 1981.
5. Kreyszig E. "Advanced Engineering Mathematics", 8th Ed., John Wiley & Sons, New York, 2001.
6. Joshi A.W. "Matrices and Tensors in Physics", 3rd Ed., New Age International Publishers, New Delhi, 1995.

PH-513 Electronics [3-1-0]

Electronic Devices: MESFETs and MOSFETs, Unijunction transistor (UJT), Four layer (PNPN) devices, Construction and working of PNPN diode, Semiconductor controlled rectifier (SCR) and Thyristor.

Electronic Circuits: Multivibrators (Bistable, Monostable, Astable), Differential amplifier, Operational amplifier (OP-AMP), OP-AMP as inverting, Non-inverting, Scalar, Summer, Integrator, Differentiator, Schmitt trigger and Logarithmic amplifier, Electronic analog computation circuit.

Communication Systems: Basic concepts of communication systems, Need for modulation, Information in communication system, Coding, Types of Pulse modulation, Pulse width modulation (PWM), Pulse position Modulation (PPM), Principle of Pulse code modulation (PCM).

Fiber Optics: Modes and configurations, Numerical Aperture, Optical sources – LED's and Lasers, Coupling sources to fibers, Optical detectors – p-i-n and APD detectors, Passive Optical components.

Microwave Devices: Principal and working of Gunn diode, IMPATT diode, Operation of Klystrons, Reflex klystrons and Magnetron.

Books Recommended:

1. Millman and Halkias "Electronic Devices and circuits"
2. Streetman Ben G and Banerjee "Solid State Electronic Devices", 5th Ed., Prentice Hall of India Ltd, New Delhi, 2004.
3. Sze S M. "Physics of Semiconductors Devices", John Wiley and sons, New Delhi.
4. George Kennedy "Electronic Communication Systems", 3rd Ed., Tata McGraw Hill Publishing Company, New Delhi, 1984.
5. Liao S.Y. "Microwave Devices and Circuits", Prentice Hall of India, New Delhi, 1995.
6. Mithal G.K. "Electronic Devices and Circuits", Khanna Publishers, Delhi, 1998.
7. Fiber Optics by Stewart D. Personick, Khanna Publisher.
8. Optical Fiber Communication by Gerd Keiser, McGraw Hill.

PH-514 Computational Techniques [3-1-0]

Programming (FORTRAN): Representation of integers, reals, characters, constant and variables, arithmetic expressions and their evaluation using rules of hierarchy. Assignment statements, Logical constants variables and expression, control structures, sequencing alternation, arrays, Manipulating vectors and matrices, Subroutines, I/O Statements

Roots of Equations: Non-linear equation: Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphson method, Bairstow Method, Solution of set of non-linear equations.
Solution of Simultaneous Linear equation: Direct Method: Gauss elimination, Pivoting, Gauss-Jordon method, Matrix inversion. Iterative methods: Jacobi iteration method, Gauss Seidel iteration method.

Interpolation: Interpolation, Newton's formula for forward and backward interpolation, Divided difference, Symmetry of divided differences, Newton's general interpolation formula, Lagrange's interpolation formula, Cubic splines, Least square approximation, Interpolation in multidimension.

Numerical Differentiation and Integration: Derivatives using forward and backward difference formula Numerical integration, A general quadrature formula for equidistant ordinates, Trapezoidal rule, Simpson's rule, Weddle's rule, Romberg integration, Gauss quadrature formula, multiple integrals.

Differential Equation: Ordinary differential equation: Euler's method, Modified Euler's method, Runge-Kutta Method, system of coupled first order ordinary differential equations. Partial differential equations: An elementary idea about numerical solution of partial differential equations using finite difference method.

Books Recommended:

1. Rajaraman V. "Computer Programming in Fortran-90 and 95", Prentice Hall of India Ltd., New Delhi.
2. Stephen J. Chapman," Fortran 90/95 for Scientists and Engineers", McGraw Hill Education
3. William Press, "Numerical Recipes in Fortran", Cambridge University Press India Pvt Ltd.
4. Joe D. Hoffman, "Numerical methods for scientist and engineers", Marcel Dekker Inc, New York
5. Steven C Chapra, Raymond P Canale "Numerical Methods for Engineers", Tata McGraw-Hill Education
6. Srimanta Pal "Numerical Methods: Principles, Analysis, And Algorithms", Oxford University Press
7. Scarbrough James B "Numerical Mathematical Analysis", Oxford and IBH Publishing Company, New Delhi, (1966).
8. Conte S.D. "Elementary Numerical Analysis", Tata McGraw Hill Publishing Company, New Delhi.

PH-515 Quantum Mechanics-I [3-1-0]

Linear Vector Space and Matrix Mechanics: Vector spaces, Schwarz inequality, Orthonormal basis, Schmidt orthonormalisation method, Operators, Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schrodinger representations, symmetries and conservation laws, parity operator, Exchange operator and identical particles.

Stationary State Approximate Methods: Variational method with application to the ground states of harmonic oscillator, Hydrogen atom, Helium atom; WKB method: Bound states for potential with and without rigid walls, tunnelling through the barrier

Angular Momentum: Solution of the Schrodinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigenvalues and eigenvectors of L^2 and L_z. Spin angular momentum, General angular momentum, Eigenvalues and eigenvectors of J^2 and J_z. Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients.

Books Recommended:

1. Sakurai J.J. "Modern Quantum Mechanics", Pearson Education Pvt. Ltd., New Delhi, 2002.
2. Mathews P.M. and Venkatesan K. "A Text Book of Quantum Mechanics", Tata McGraw- Hill Publishing Company, New Delhi, 1981.
3. Khanna M.P. "Quantum Mechanics", Har Anand, New Delhi, 1996.
4. Thankappan V.K. "Quantum Mechanics", Wiley Eastern, New Delhi, 1985.
5. Powell J.L. and Crasemann B "Quantum Mechanics", Narosa Publishing House, New Delhi.
6. Merzbaber E. "Quantum Mechanics", John Wiley & Sons, Inc., New York, 1970.

PH-516 Solid State Physics-I [3-1-0]

Crystal structure and binding in solids: Bravais lattice, lattice planes and miller indices, reciprocal lattice, Diffraction conditions, Brillouin zones, Atomic Structure factor; types of crystal binding, cohesive energy of ionic crystals.

Defects and Diffusion in solids

Point defects: Schottky and Frenkel vacancies, Diffusion, Fick's law. Color centers, *F*-centers. Line defects (dislocation): Edge and Screw dislocation, Burger's vector, Slip, Planar (stacking) faults: Grain boundaries: Low angle grain boundaries.

Elastic Properties

Introduction, Analysis of Stress- strain relations, Elastic Compliance and Stiffness Constants, Elastic Waves in Cubic Crystals.

Thermal Properties: Phonon heat capacity, Density of states, Debye and Einstein theory of specific heat, Lattice Thermal Conductivity and Umklapp Processes, specific heat of metals.

Semiconductors: Direct and Indirect Absorption Processes, Equations of motion, effective mass, intrinsic carrier concentration, impurity conductivity, Cyclotron resonance and Magnetoresistance in semiconductors.

Fermi Surfaces and Metals: Zone schemes, Fermi surfaces; Hall Effect, Electron, Hole and Open orbits, Quantization of orbits in a magnetic field, the de Hass-van Alphen Effect, External orbits.

Dielectrics: Macroscopic field, The local field, Lorentz field, The Claussius- Mossotti relation, different contributions to polarization: dipolar, electronic and ionic polarizabilities.

Recommended Books:

1. Kittle C "Introduction to Solid State Physics", John Wiley & Sons, 2005.
2. Dekkar A J "Solid State Physics", Macmillan India Ltd., New Delhi, 2004.
3. Azaroff L V "Introduction to Solids", Tata McGraw-Hill Publishing Company, New Delhi, 1992.
4. Ashcroft N W and Mermin N D "Solid State Physics", Thomson Asia Pte. Ltd., 2006.

1. Singh, R.J., Solid State Physics, Pearson, Press, 2012.

PH-517 Atomic & Molecular Spectroscopy [3-1-0]

Quantum States of One Electron Atom: Atomic orbitals-Hydrogen spectrum – The Pauli Exclusion Principal – Ritz combination principal Spectra of alkali elements, Spin – orbit interaction; Larmor's theorem and the fine structure in alkali spectra – Equivalent and non-equivalent electrons-penetrating and non-penetrating orbits, quantum defect and screening parameter, selection rules and intensity rules, breadth of spectrum-Doppler effect, Natural breadth, external effects.

Two Electron Systems: General characteristics of the energy levels of alkaline earth elements; selection rules and intensity rules, Interaction energy in LS or Russell-Saunder's coupling and JJ coupling – in LS coupling, Hyper fine structure (qualitative) Normal and Anomalous Zeeman effect-Paschen Backeffect, Stark effect, Lande's g factor in LS coupling.

Molecular Structure: Types of molecules-Diatomic linear symmetric top, asymmetric top and spherical top molecules-Rotational Spectra of diatomic molecules as a rigid rotator-Energy levels and spectra of non rigid rotor-intensity of rotational lines Vibrational energy of diatomic molecule as a simple harmonic oscillator – Energy levels and spectrum – Morse potential energy curve-Molecules as vibrating rotator – Vibration spectrum of diatomic molecule – PQR branches IR spectrometer (qualitative).

Spectroscopy: Raman effect – Quantum theory- Molecular polarisability – Pure rotational spectra of diatomic molecules – Vibration rotation Raman spectrum of diatomic molecules – intensity alteractions in Raman spectra of diatomic molecules-Experimental set up for Raman spectroscopy – Application of IR and Raman spectroscopy in the structure determination of simple molecules Born Oppenheimer approximation – Franck Condon principle – dissociation and pre-dissociation – Dissociation energy.

Books Recommended:

1. Introduction to Atomic Spectra: H.E. White Tata Mcgraw Hill.
2. Fundamentals of molecular spectroscopy: C.B. banwell
3. Spectroscopy Vol. I, II & III: Walker & Straughen
4. Introduction to Molecular spectroscopy: G.M. Barrow
5. Spectra of diatomic molecules: Herzberg
6. Molecular spectroscopy: Jeanne L McHale
7. Molecular spectroscopy: J.M. Brown
8. Spectra of atoms and molecules: P.F. Bermath
9. Modern spectroscopy: J.M. Holias
10. Electromagnetic: B.B. Laud

PH-518 Electrodynamics [3-1-0]

Electrostatics: Introduction, Work and Energy in electrostatics, Polarization, Laws of electrostatic field in the presence of dielectrics, Energy of the field in the presence of a dielectric, Boundary condition, Poisson and Laplace equations, Earnshaw's theorem, Boundary conditions and Uniqueness theorem, Multipole expansion, Method of electrostatic images.
Magnetostatics: Introduction, Laws of magnetostatics, Magnetic scalar and vector potentials, Magnetic media, magnetization, magnetic field vector, Boundary conditions.

Time Varying Fields: Maxwell's equations, Displacement current, Electromagnetic potential, vector and scalar potential, Gauge transformations; Lorentz and Coulomb Gauge, Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, continuity equation.

Electromagnetic Waves: Plane waves in Non-conducting and conducting media Polarization-linear and circular polarization. Skin effect, Reflection and refraction of electromagnetic waves across a dielectrics interface at a plane surface between dielectrics. Total internal reflection, Polarization by reflection, Reflection from the surface of a metal.

Electromagnetic Radiation: Retarded Potentials, Radiation from an oscillating Dipole, Lienard-Wiechert Potentials, Potentials for a charge in uniform motion-Lorentz Formula, Fields of an accelerated charge.

Books Recommended:

1. Jackson J.D. "Classical Electrodynamics", John Wiley & Sons Pvt. Ltd., New York, 2004.
2. Griffiths D.J." Introduction to Electrodynamics", Pearson Education Pvt. Ltd., New Delhi, 2002.
3. Marian J.B and Heald M.A. "Classical Electromagnetic Radiation", Academic Press, New Delhi,
4. Puri S.P. "Classical Electrodynamics", Tata McGraw-Hill Publishing Company, New Delhi.
5. Jordon E.C. and Balmain K.G. "Electromagnetic Waves and Radiating Systems", Prentice Hall of India, New Delhi, 1995.

PH-519 Quantum Mechanics-II [3-1-0]

Scattering Theory: Scattering Cross-Section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potential. Electron scattering by an atom. Optical theorem, Scattering of identical particles.

Perturbation Theory: An introduction to perturbation theory; its relevance, and physical examples, Time-independent perturbation theory: non-degenerate case, Time-independent perturbation theory: degenerate case, Time- dependent perturbation theory; atom- field interactions and the dipole approximation, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.

Relativistic Quantum Mechanics: Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle, The non-relativistic limit of Dirac equation, Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom.

Books Recommended:

1. Sakurai J.J. "Modern Quantum Mechanics", Pearson Education Pvt. Ltd., New Delhi, 2002.
2. Mathew P.M. and Venkatesan K. "A Text Book of Quantum Mechanics", Tata McGraw-Hill Publishing Company, New Delhi, 1981.
3. Khanna M.P. "Quantum Mechanics", Har Anand, New Delhi, 1996.
4. Thankappan V.K. "Quantum Mechanics", Wiley Estern, New Delhi, 1985.
5. Mandel H. and Shaw G. "Quantum Field theory", Wiley Eastern, New Delhi, 1984.

PH-520 Solid State Physics-II [3-1-0]

Dia-, Para- and Ferro-magnetism: Classification of magnetic materials, the origin of permanent magnetic dipoles, diamagnetic susceptibility, Langevin's classical theory of diamagnetism; Classical theory of Para magnetism, Quantum theory of Para magnetism, Quenching of orbital angular momentum, Cooling by adiabatic demagnetization, Paramagnetic susceptibility of conduction electrons; Ferromagnetism, Spontaneous magnetization in ferromagnetism, The Weiss molecular field, The interaction of the Weiss field, Ferromagnetic domains, Bloch wall, Spin waves, Quantization of spin waves, Thermal excitations of magnons.

Antiferro and Ferri-magnetism

The two sub lattice model, exchange interaction, Neel's Temperature; Structure of ferrites, Saturation magnetization, Neel's theory of ferrimagnetism, Curie temperature and susceptibility of ferrimagnets

Superconductivity

Superconductivity, zero resistivity, critical temperature, Meissner effect, Type I and Type II superconductors, specific heat and thermal conductivity, London Equations, BCS theory, Ginzburg-Landau theory, Josephson effect: dc Josephson effect, a c Josephson effect, macroscopic quantum interference, High temperature superconductivity (elementary).

Ferro-electrics: General properties of ferroelectric materials. The dipole theory of ferroelectricity, objection against dipole theory, Pizo and pyroelectrics (elementary idea)

Optical properties: Optical constants and their physical significance, Kramer-Kroning relations, Electronic interband transitions, Frenkel and Mott-Wannier excitons.

Ordered phases of matter: Translational and orientational order, Liquid crystal phases; nematic, smectic, cholestric, Landau Theory of isotropic- nematic phase transitions, Physics of LCD devices, Quasi crystals

Recommended Books:

1. Kittle C "Introduction to Solid State Physics", John Wiley & Sons, 2005.
2. Dekkar A J "Solid State Physics", Macmillan India Ltd., New Delhi, 2004.
3. Ashcroft N W and Mermin N D "Solid State Physics", Thomson Asia Pte. Ltd., 2006
4. Omar M Ali, "Elementary solid state physics, Principles and applications", Pearson Press, 2011
5. Hamley Ian W, "Introduction to Soft Matter: Synthetic and Biological Self-Assembling Materials", John Wiley, 2007
6. Colling P J , "Liquid Crystals", Princeton Univ. Press, Second Edition, 2002

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PH-521 Plasma Physics [3-1-0]

Basics of Plasmas: Occurrence of Plasma in nature, Definition of plasma, Concept of temperature, Debey shielding and plasma parameter, Single particle motions in uniform E and B fields, Non monuniform magnetic field, grad – B drift and curvature drift, Magnetic mirror. Simple applications of plasmas.

Plasma Waves : Plasma oscillations, Electron plasma waves, Ion waves, Electrostatic electron and ion oscillations perpendicular to magnetic field, Upper hybrid waves, Lower hybrid waves, ion cyclotron waves, Light waves in plasma.

Non-linear Effects in Plasma: Introduction, Ponderomotive force, Parametric Instabilities: Coupled Oscillators, Frequency matching, Instability Threshold, Oscillating two-stream instability.

Nuclear Fusion: Introduction, Lawson criteria, Fundamentals of inertial confinement fusion, Fundamentals of magnetic confinement method, Tokamak, Hydrodynamics of implosion.

Books Recommended:

1. Chen F F "Introduction to Plasma Physics and Controlled Fusion", Plenum Press, New York, 1980.
2. Krall N.A. and Trivelpiece A.W. "Principle of Plasma Physics", Tata McGraw- Hill Publishing Company, New Delhi, 1972.
3. Dendy R "Plasma Physics", Cambridge University Press, New York, 1996.
4. Friedberg J P "Ideal Magnetohydrodynamics"
5. Seshadri S R "Fundamental of Plasma Physics",
6. Chanchal Uberoi "Introduction to Unmagnetized Plasma", Prentice Hall of India Pvt. Ltd., New Delhi, 1997

PH-522 Nuclear Physics [3-1-0]

Nuclear Properties: Introduction, constituents of nucleus and their intrinsic properties, angular momentum, magnetic moment and electric quadrupole moment of nucleus, wave mechanical properties of nucleus, nuclear forces

Nuclear Interactions: Nuclear force: Two nucleon system**,** deuteron problem, binding energy, nuclear potential well, pp and pn scattering experiments at low energy, meson theory of nuclear force, e.g. Bartlett, Heisenberg, Majorana forces and potentials, exchange forces and tensor forces, effective range theory-spin dependence of nuclear force, Charge independence and charge symmetry of nuclear forces-Isospin formalisim, Yukawa interaction

Nuclear Models: Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Applications of Shell model like Angular momenta and parities of nuclear ground states, Quantitative discussion and estimates of transition rates, magnetic moments and Schmidt lines, Collective model-nuclear vibrations spectra and rotational spectra

Nuclear Decay: Beta decay, Fermi theory of beta decay, shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions, selection rules, parity violation, Two component of neutrino decay, Detection and properties of neutrino, Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules, Internal conversion, Nuclear isomerism.

Nuclear Reaction: Conservation laws, energetics of nuclear reaction, Direct and compound nuclear reaction mechanism, Compound nuclear-scattering matrix, Reciprocity theorem, Breit Wigner one level formula, Resonance scattering.

Books Recommended:

1. Bohr A. and Mottelson B.R. “Nuclear Structure”, Vol. 1 (1969) and Vol.2 (1975), Benjamin, Readings, A.
2. Krane K. S. “Introductory Nuclear Physics”, Wiley Estern, New York, 1988.
3. Roy R.R. & Nigam B.P. “Nuclear Physics”, New Age International, New Delhi.
4. Irving Kaplan “Nuclear Physics”, Addison Wesley, New Delhi.
5. Pal M. K. “Theory of Nuclear Structure”, East West Press Pvt. Ltd., New Delhi.
6. Hans H.S. “Nuclear Physics: Experimental and Theory”, New Age International, New Delhi, 2001.

PH-523 Particle Physics [3-1-0]

Introduction and Overview: Historical development, Particle classification: Bosons, Fermions, Particles and Antiparticles, Quarks and Leptons; Basic ideas about the interactions and fields in Particle Physics, Types of interactions: Electromagnetic, Weak, Strong and Gravitational, Natural System of Units in High Energy Physics.

Invariance Principles and Conservation laws: Conservation of electric charge, Baryon number, Lepton number, Continuous symmetry transformations: translation and rotation; Parity, Pion parity, Charge conjugation, Strangeness and Isospin, Two Nucleon System, Pion-Nucleon System, G-parity, Time reversal invariance, Associated production of particles and Gell-Mann Nishijima scheme, $K^0 - \overline{K^0}$ doublet, CP violation in K- decay, CPT theorem

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Electromagnetic Interactions. Form factors of nucleons. Parton model and Deep inelastic scattering structure functions, Cross Section and Decay Rates.

QCD and Quark model: Asymptotic freedom and Infrared slavery, confinement hypothesis. Classification of hadrons by flavor symmetry : SU(2) and SU(3) multiplets of Mesons and Baryons. The Baryon Octet and Decuplet, Pseudoscalar mesons and Vector mesons.

Weak interactions: Classification of weak processes, Fermi theory of β- decay, Parity non conservation in β - decay, two component theory of neutrino and determination of helicity, V-A interaction, Strangeness changing and non-changing decays, Cabibbo's theory.

Gauge invariance and Unification schemes: Global and Local invariance of the Action, Noether's theorem, Spontaneous breaking of symmetry and Goldstone theorem. Abelian and Non-Abelian gauge fields.

Books Recommended:

1. Introduction to High Energy Physics, D.H. Perkins.
2. Introduction to Particle Physics, M.P. Khanna.
3. Introduction to Elementary Particles, D. Griffiths.
4. Particle Physics, Martin and Shaw.
5. Introduction to Quarks and Partons, F.E. Close
6. Quarks and Leptons: An Introductory Course in Modern Particle Physics, F. Halzen and A.D. Martin.

PH-524 Statistical Physics [3-1-0]

Review of Thermodynamics: Extensive and intensive variables, Laws of thermodynamics and their consequences, Thermodynamic potentials, Maxwell’s thermodynamical relations

Classical Statistical Mechanics: The macroscopic and microscopic states, Postulate of equal a priori probability, contact between statistics and thermodynamics, classical ideal gas, Gibbs' paradox, phase space and Liouville’s theorem and its consequences, Microcanonical, canonical, and grand canonical ensembles, partition functions, fluctuation of energy and density, Equipartition and virial theorems, Derivation of thermodynamic properties; some examples including (i) Classical ideal gas (ii) system of classical harmonic oscillators

Quantum Statistical Mechanics: Quantum-mechanical ensemble theory: Density matrix, simple applications of density matrix. Symmetric and Antisymmetric Wavefunctions. Microcanonical ensemble of ideal Bose, Fermi and Boltzmann gases. Statistics of the occupation numbers

Ideal Bose and Fermi Systems: Thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, Blackbody radiation and Plancks law of radiation, Thermodynamic behaviour of an ideal Fermi gas, Magnetic behavior of an ideal Fermi gas, Pauli paramagnetism

Phase Transition and critical phenomenon: First and second order phase transitions, Ising model, Critical exponents, Landau theory of phase transitions.

Books Recommended:

1. Patharia R.K. “Statistical Mechanics”, Pergamon, Oxford.
2. Kerson Huang “Statistical Mechanics”, Wiley Eastern, New Delhi.
3. Kittel C. “Elementary Statistical Physics”, Wiley Eastern, New Delhi.
4. Agarwal B.K. and Eisner M “Statistical Mechanics”, Wiley Eastern, New Delhi.
5. Chandler D. “Introduction to Modern Statistical Mechanics”, Oxford University Press, New Delhi

PH-541 Electronics Laboratory [0-0-2]

List of Experiments:

1. Measurement of amplitude, frequency and phase of given signals using oscilloscope.
2. Study the characteristics of FET.
3. To study pulse amplitude, Pulse width and Pulse position modulations.
4. To study the frequency response of an operational amplifier.
5. To study use of operational amplifier for different mathematical operations.
6. To study the characteristics of inverting and non inverting operational amplifier.
7. To study the characteristics of multivibrators – bistable, Astable, monostable.
8. To determine the numerical aperture (NA) of a given multimode fiber.
9. To study a simple intensity modulated fiber-optic press;lkjure sensor.
10. To study the characteristics of klystron oscillator/amplifier.
11. To study the characteristics of GUNN oscillator.
12. Study of radiation pattern of a given planar antenna (microstrip).
13. Study the s-parameters of stripline base components and calculate its impedance.
14. To study the logic gates (IC trainer)

PH-542 Computer Laboratory [0-0-2]

List of Experiments:

1. **Determination of Roots:**
   a) Bisection Method
   b) Newton Raphson Method
   c) Secant Method
   d) Coupled non-linear equations

2. **Matrix Manipulation:**
   a) Matrix Multiplication
   b) Determinant
   c) Gauss Elimination
   d) Matrix Inversion
   e) Gauss Jordan

3. **Interpolation:**
   a) Forward interpolation, Backward interpolation
   b) Lagrange's interpolation
   c) Least square method

4. **Integration:**
   a) Trapezoidal Rule
   b) Simpson 1/3 and Simpson 3/8 rules
   c) Multiple integral

5. **Differential Equations:**
   a) Euler's method
   b) Runge Kutta Method
   c) Coupled first order differential equations
   d) Solution of partial differential equation

PH-543 Solid State Physics Laboratory [0-0-2]

List of Experiments:

1. To determine charge carrier density and Hall coefficient by Hall Effect.
2. To determine the band gap of a semiconductor using p-n junction diode.
3. To determine magnetic susceptibility of material using Quink's tube method.
4. To determine energy gap and resistivity of the semiconductor using four probe method.
5. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization.
6. To find magneto resistance of semiconductor.
7. To determine dielectric constant of a material with Microwave set up.
8. Study the micro-textures and phase transition temperatures in liquid crystal cell.
9. Study the Curie temperature and dielectric constant of ferroelectric material.
10. Study the dielectric properties of ferroelectric/ nematic liquid crystalline material in planar cell configuration.
11. Study the voltage and temperature dependence behaviour on optical responses of liquid crystal using He-Neon laser

PH-544 Spectroscopy Laboratory [0-0-2]

List of Experiments:

1. To find the wavelength of monochromatic light using Febry Perot interferometer.
2. Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer.
3. To find the wavelength of sodium light using Michelson interferometer.
4. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.
5. To find the grating element of the given grating using He-Ne laser light.
6. To find the wavelength of He-Ne laser using Vernier calipers.
7. To study Faraday effect using He-Ne Laser.
8. To verify the existence of Bohr’s energy levels with Frank-Hertz experiments.
9. Determination of Ionization Potential of Lithium.
10. Determination of Lande’s factor of DPPH using Electron-Spin resonance (E.S.R.) Spectrometer.
11. To study the fluorescence spectrum of DCM dyes and to determine the quantum yield of fluorescence maxima and full width at half maxima for this dye using monochromator.

PH-545 Nuclear Physics Laboratory [0-0-2]

List of Experiments:

1. To study the characteristics of G.M. counter.
2. To determine the dead time of G.M. counter.
3. To study absorption of beta particles is matter.
4. To study Gaussian distribution using G.M. counter.
5. Source strength of a beta-source using G.M. counter.
6. Study of Poisson distribution.
7. To investigate the statistics of radioactive measurements.
8. Determination of Planck's constant using Photocell and Interference filters.
9. Recording and calibrating a gamma ray spectrum by scintillation counter.
10. To calibrate the scintillation counter using a known Gamma Source.
11. To study absorption of gamma radiation by scintillation counter.
12. Identifying and determining the activity of weakly radioactive samples.
13. Recording a beta spectrum using a scintillation counter.
14. Demonstrating the tracks of α- particles in a Wilson cloud chamber.
15. Rutherford scattering: measuring the scattering rate as a function of the scattering angle and the atomic number.
16. Study of nuclear magnetic resonance in polystyrene, glycerin and Teflon.
17. Quantitative observation of the Compton Effect.
18. Deflection of beta radiation in a magnetic field.

PH-546 Plasma Laboratory [0-0-2]

List of Experiments:

1. Study of Plasma parameters such as Electron density, ion density, Electron temp, floating potential, Plasma Potential etc. by using Single and Double Langmuir probe.
2. Verification of Paschen curve.
3. Study of Plasma coating of different materials on substrate.
4. Study of Plasma cleaning of substrate surfaces.
5. Demonstration of microwave plasma.
6. Study of collective behavior of a plasma by launching and detecting ion acoustic waves.
7. To study the conditions of occurrence of striations

PH- 531 Nuclear Accelerator and Radiation Physics

Detection of Nuclear Radiations and their measurements: Methods for detection of free change carriers, Ionization chamber, Proportional counter, Geiger-Muller counter, Semiconductor detectors, Scintillation detector, Cheremkov detector, Wilson cloud chamber, Bubble chamber, Spark chamber, Nuclear emulsion techniques, Solid State nuclear track detector.

Determination of Nuclear Properties: Nuclear mass measurement, Ion optics, Production and detection of positive ions, Dempster's mass spectrometer, Aston's and Bainbridge's mass spectrograph, Double focusing mass spectroscope, Measurement of nuclear spin and magnetic moment, Nuclear spin from Zeeman effect of hyper fine lines, Nuclear spin and statistics from molecular spectra, Atomic beam method of nuclear magnetic moment determination, Magnetic resonance absorption method, Nuclear induction and microwave spectroscopy method.

Accelerators of Charged Particles: Classification and performance characteristics of accelerators, Ion sources, Electrostatics accelerators, Cockroft – Walton generator, Cyclotron, Synchro-cyclrotron, Betatron, Electron and proton synchrotron, Microtron, Linear accelerator.

Neutrons and Neutron Physics: Classification and properties of neutron, Sources of neutron, Neutron detectors; Slow neutron detection through nuclear reactions and induced radioactivity, Fast neutron detection, Neutron monochromators, Diffusion of thermal neutron.

Books Recommended:

1. Lapp R E and Andrews H L "Nuclear Radiation Physics", Fourth edition, Prentice Hall, New Delhi, 1963.
2. Mc Dowell C A "Mass spectroscopy", McGraw Hill Book Company, New Delhi, 1963.
3. Segre E "Experimental Nuclear Physics", John Wiley and Sons, 1953.
4. Livingstone M.S. and Blewett J P "Particle Accelerators", McGraw Hill Book Co., 1962.
5. Kapoor S S and Ramamurthy V S "Nuclear Radiation Detectors" Wiley Eastern, New Delhi, 1986.
6. Glasstone S "Principles of Nuclear Reactor Engineering", Mc Millan Co. London, 1956.
7. Ghoshal S N "Nuclear Physics", S Chand and Co., New Delhi, 2006.

PH – 532 OPTO-ELECTRONICS

Introduction : Light, elements of solid state physics, modulation of light, Review of Energy bands, effective mass, Fermi level, classification of semiconductors into element, binary, ternary and quaternary compounds, conduction mechanisms, amorphous semiconductors. Contact potential explanation based on band structure, M-S contact and its properties, barrier layer, P-N junction, potential barrier and barrier width, forward and reverse saturation current junction capacitance.

Processing of Semiconductor Materials: Purification, Zone refining and zone floating methods, Epitaxial growth methods, liquid phase, vapour phase and molecular beam epitaxy. Introduction of impurities, junction,successive doping method, epitaxial and diffusion methods, MESA and planar structure doping of amorphous semiconductors.

Displays devices and photo detectors: Luminescence from quantum well, photo luminescence and phosphorescence, phototransistors electro luminescence process, LED's their structures and choice of materials, Plasma displays, liquid crystal displays Introduction, thermal detector, photon devices and their characteristics, solar cells, photomultimeter

Laser: Emission and absorption of radiation, population inversion, pumping, doped laser, gas laser, semiconductor laser, liquid dye laser, laser modes and holography

Recommended Books:

1. S.M.Sze, "Physics of Semiconductor Devices", 2nd Ed., Wiley, New York,2000.
2. P.Bhattacharya, "Semiconductor Opto-electronic Devices", PHI, 1996.
3. J.Wilson & J.F.B.Hawkes, "Optoelectronics", PHI, 1998.
4. S.S. Islam, "Semiconductor Physics and Devices", Oxford University Press, 2005.
5. A. K. Ghatak & K Thyagarajan, "Optical Electronics", Cambridge University Press, 1989.

PH – 533 Microwave Electronics

Introduction: Microwaves and its frequency spectrum, Application of microwaves, Waveguides - Rectangular wave guides, Circular wave guide, Wave equations & their solutions, TE, TM & TEM modes. Attenuation - Cause of attenuation in wave guides, wall current & derivation of attenuation constant, Q of the wave guide. Resonators - Resonant Modes of rectangular and cylindrical cavity resonators, Q of the cavity resonators, Excitation techniques, Introduction to Microstrip and Dielectric resonators. Microwave propagation in ferrites, Faraday rotation, Devices employing Faraday rotation (isolator,Gyrator,Circulator). Introduction to single crystal ferromagnetic resonators, YIG tuned solid state resonators.

Microwave tubes: Spacecharge spreading of an electron beam, Beam focusing, Klystrons - Velocity Modulation, Two Cavity Klystron, Reflex Klystron, Efficiency of Klystrons. Magnetrons - Modes of oscillation & operating characteristics, Traveling wave tubes.

Devices: Avalanche Transit Time Device - Read Diode, Negative resistance of an avalanching p-n Junction diode, IMPATT and TRAPATT, Transferred Electron Device - Gunn effect, two valley model, Different Modes for Microwave generation, Passive Devices - Termination (Short circuit and matched terminations) Attenuator, Phase changers, Tees, Hybrid Junctions, Directional coupler.

Parametric Amplifier: Varactor, Equation of Capacitance in Linearly graded & abrupt p-n junction, Parametric upconvertor, Negative resistance parametric amplifier, Noise in parametric amplifiers.

Microwave Antennas: Introduction to antenna parameters, Potential functions, Radiation from a aperture antenna, Electromagnetic Horns, Prabolic reflectors, Microstrip antenna, Introduction to antenna arrays.

Texts/References:

1. Jorden & Balmain, "Electromagnetic waves & Radiating Systems", PHI, 1993.
2. Atwater, "Introduction to Microwave Theory", McGraw Hill, 1962.
3. M.L. Sisodia and G.S. Raghuvanshi, "Microwave Circuits & Passive Devices", New Age International, 1988.
4. R. E. Collin, "Foundations of Microwave Engineering", McGraw Hill, 2001.
5. H.A. Watson, "Microwave Semiconductor Devices and Their Circuit Applications", 1969.
6. C.A. Balanis, "Antenna Theory", Harper & Row. Pub. & Inc., New York, 1997.
7. S.Y.Liao, "Microwave Devices & Circuits", PHI.
8. H.J. Reich, "Microwave Principles", PHI, 1990.

PH – 534 Polymer Physics

Induction to Polymer Science: Fundamental definition, Configurational state, Homopolymer & Copolymer, Degree of polymerization, Thermal transitions and Physical structures - linear, Branched, Crosslinked polymer & Network, Number Average and Weight Average, Molecular Weight, Significance of Molecular Weight.

Rheology and the mechanical properties of polymers: Viscous Flow, Kinetic Theory of Rubber Elasticity, Visco Elasticity, the glass stage and the glass transition, the Mechanical Properties of Crystalline Polymers.

Polymer processing: Plastic, Rubber and Fiber of Commercial Importance, Polymer Auxiliaries, Plasticizers, Stabilizers, Fillers, Lubricants etc., Manufacture Processing and Properties of Major Thermosetting Resins. Thermoplastics, Elastomers and Fiber Forming Polymers, Reinforcement, Fabrication, Formulation, Vulcanization Theory and Technology.

Applications of Polymers

Book Recommended:

1. Gowariker V.R., Viswanathan N. V. and Sreedhar J, "Polymer Science", Wiley-eastern, 1991.
2. Ghosh P "Polymer Science and Technology of Plastics and Rubber", Tata McGraw Hill, 1990.
3. Billmeyer F.M "Text Book of Polymer Science", John Wiley and Sons, New York, 1984.

PH - 535 DIGITAL ELECTRONICS [3-0-0]

Boolean Algebra and Combinational Logic: Review of Boolean Laws & Theorems; Logic Families; TTL NAND operation, Gate circuits; Standard forms of Boolean expressions (SOP & POS form) and their implantation; Karnaugh simplification of SOP & POS expressions, Don't care conditions. Multiplexer and Demultiplexer; Comparators, Encoder and Decoder; Parity generators and checkers, Adder-Subtract circuits.

Latches, Flip-Flop and Timers: Clock waveform and its characteristics; RS, JK, JK-master slave, Timer-555, D and T Flip Flops (Unlocked, Locked and Edge triggered).

Registers and Counters: Buffer register, control register, Shift Registers (SISO, SIPO, PISO and PIPO), Control shift register**;** Modulus of Counter; ripple counters, ring counter, Asynchronous 2-bit, Up/Down and decade counter; Design of synchronous counter (Mod-8), TTL counter.

Memories: ROM, PROM and EPROM, RAM, Static and Dynamic Random Access Memories (SRAM and DRAM), content addressable memory, other advanced memories.

D/A and A/D Converters: Parallel comparator A/D converter, successive approximation A/D converter, Counting A/D converter, Dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion – accuracy and resolution. D/A converter resistive network, accuracy and resolution.

Books Recommended:

1. "Modern Digital Electronics", R. P. Jain, Tata McGraw-Hill Publishing Company; 4th Edition (2009).

2. "Digital Principles and Applications", D. P. Leach, Albert Paul Malvino and G. Saha, McGraw-Hill Publishing Company (2010).

3. "Digital Fundamentals", T. L. Floyd, Pearson Prentice-Hall (2011).

4. "Digital Electronics: Circuits and Systems", V. K. Puri, Tata McGraw-Hill Publishing Co. Ltd. (2001).

PH - 536 NUCLEAR INSTRUMENTATION (3-0-0)

General: Introduction to Properties of Nuclear Systems & Radiation, Interaction of radiation with matter, radioactive sources- choice of isotopes.

Radiation detectors- Radioactivity and matter: Nuclear properties; Radiation detection and measurement. Ionization chamber, Geiger Muller counters, Scintillation counters, Semi conductor devices, Neutron detectors based on recoil measuring circuits including modulators; converters& stabilizers, Synchronous detectors. Nuclear techniques and analytical instruments, X.R.F techniques, Industrial instruments, density estimation of the fluids, Medical instrumentation, thyroid estimation, CT, MRI. Gamma Ray Spectroscopy Technique.

Safety: Hazards of ionization radiation, physiological effect of radiation, dose and risk radiological protection (alpha, beta and gamma, X, neutron)-shielding material and effectiveness. Operational safety instrument, emergency schemes, effluent disposal, application to medical diagnosis and treatment. Effects of Ionising Radiations, Induction of cancers, Risk Assessments, Risk factors for cancers, Hereditary disease, Communal risk, Other late effects, Irradiation in pregnancy, System of Radiological Protection, Central principles, Scope of application, Justification of practices, Optimisation of protection, Limitations of doses, Constraints, Comparing risks, Legal controls.

BOOKS RECOMMENDED:

1. Vashtell,C.C ,S.G Hewit Nucleonic instrumentation, Newnes,(1965).

2. Michael Sayer and Abhai Mansingh, Measurement, Instruments and Experimental Design in Physics and Engineering, PHI, (2000).

3. Glen F. Knoll, Radiation Detection and Measurement, 4th Edition, Wiley Science, (2010).

4. Modern Physics by G. Aruldhas and P. Rajgopal, Publisher: PHI. ISBN-81-203-2597-4.

PH-537 Quantum Field Theory [3-0-0]

Canonical Quantization: Resume of Lagrangian and Hamiltonian formalism of a classical field, Second quantization: Concepts and illustrations with Schrodinger field.

Klein Gordan Field: Quantization of a real scalar field and its application to one meson exchange potential, Quantization of a complex scalar field.

Dirac Field: The Dirac Equation, Relativistic Covariance. Anti-Commutators, Quantization of the Dirac Field, Electrons and Positrons.

Gauge Field: Gauge Invariance and Gauge Fixing. Quantization of the Electromagnetic Field, Propagator, Vacuum Fluctuations.

Interacting Theory and Elementary Processes: Feynman diagrams and their applications, Lowest Order Cross-Section for Electron-Electron, Electron-Positron and Electron-Photon Scattering, Wick's Theorem, Scattering matrix and Higher order corrections.

Books Recommended:

1. Quantum Field Theory, C. Itzykson and J. B. Zuber, McGraw-Hill Book Co, 1985.
2. Quantum Field Theory, L. H. Ryder, Cambridge University Press, 2008.
3. Field Theory, A Modern Primer, P. Ramond, Benjamin, 1980.
4. The Quantum Theory of Fields, Vol I, S. Weinberg, Cambridge University Press, 1996.
5. Introduction to The Theory of Quantum Fields, N. N. Bogoliubov and D. V. Shirkov, Interscience, 1960.
6. An Introduction to Quantum Field Theory, M. E. Peskin and D. V. Schroeder, Westview Press, 1995.

PH-538 Nanostructured Materials [3-0-0]

1. Introduction to Nanomaterials:

Types of Nanomaterials, Emergence and challenges in nanotechnology, Properties of Nanomaterials, role of size in Nanomaterials, nanoparticles, nanowires, nanoclusters, quantum wells, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state, Properties of Nanomaterials: Stability of Nanomaterials, Mechanical properties, Optical, Electrical and Magnetic properties, nano-diffusion.

(8)

2. Fabrication of Nanomaterials:

Synthesis routes for nanomaterials: Bottom-up and top-down approaches, Solid, Liquid, Gas phase synthesis, Hybrid Phase synthesis, Synthesis of bulk Nanostructured materials: Approaches and challenges.

(8)

Characterization techniques of nanomaterials :

Characterization of Nanostructures: Structural Characterization X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Thermal Characterization of Materials: DTA, TGA, DSC (Principle and Applications).

(8)

3. Future Applications:

MEMs, Nanomachines, Nanodevices, quantum computers, Opto-electronic devices, quantum electronic devices, Environmental and Biological applications.

(6)

4. Nanocomposites: An Introduction:

Types of Nanocomposite (i.e. metal oxide, ceramic, glass and polymer based); Core-Shell structured Nanocomposites, Superhard Nanocomposite, Mechanical Properties, Modulus and the Load-Carrying Capability of Nanofillers, Failure Stress and Strain Toughness, Glass Transition and Relaxation Behavior, Abrasion and Wear Resistance, Permeability, Dimensional Stability Contents, Thermal Stability and Flammability, Electrical and Optical Properties, Resistivity, Permittivity, and Breakdown Strength, Refractive Index, Light-Emitting Devices.

(10)

Books:-

1. Nanostructures and Nanomaterials; Synthesis, Properties and Applications

Guozhong Cao Imperial College Press

2. Introduction to Nanotechnology

Chales P Poole, Frank J Owen, Wiley India

3. Handbook on Nanotechnology Vol 5

   H S Nalwa

4. Nanostructures :- Fabrication and analysis, Springer

5. Nano: The Essentials, Understanding Nanoscience and Nanotechnology, T Pradeep, McGraw Hill

PH-539 Experimental Techniques in Physics [3-0-0]

Unit-I

Optical Microscopy; Scanning Electron Microscopy; Scanning Tunneling Microscopy; Atomic Force Microscopy; X-ray diffraction, Mass Spectrometry, Thermal Characterization.

Unit-II

Transmission Electron Microscopy; Low Energy Electron Diffraction; Reflection of High Energy Electron Diffraction; Neutron diffraction; Electron Spectroscopy for chemical analysis; Auger Electron Microscopy; Secondary ion mass spectroscopy; Electron Energy Loss Spectroscopy, Molecular spectroscopies including Microwave, FTIR, Raman and surface enhanced Raman Spectroscopy.

Unit-III

X-ray Fluorescence; Rutherford back scattering; UV-VIS-NIR spectro-photometer & Ellipsometry; Deep Level Transient Spectroscopy; Thermally Simulated Current; C-V and Admittance Spectroscopy; Hall effect and Time of Flight methods for charge carriers, Differential scanning calorimeter; Differential Thermal Analyzer.

Recommended Books:

- Sayer, M., Mansingh, A., Measurement, Instrumentation and Experiment Design in Physics and Engineering, PHI (2000).
- Nanotechnology - Molecularly Designed Materials : G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.
- Nanotechnology Molecular Speculations on Global Abundance : B.C. Crandall (MIT Press), 1996.
- Nanoparticles and Nanostructured Films–Preparation, Characterization and Application : J.H. Fendler (Wiley), 1998.

PH-540 Polymer & Liquid Crystals [3-0-0]

Polymer:

Introduction, monomer, degree of polymerizations, chemistry of polymers, polymer synthesis and polymer structure, polymers classification's, polymer morphology, thermal properties, multicomponent polymeric materials, applications.

Liquid Crystals:

Classification of liquid crystals: Thermotropic and lyotropic, Nematic, Smectic, cholestric, Ferroelectric liquid crystals (LCs), Blue phase LCs, molecular structure of LCs, structure- property relationship of thermotropic liquid crystals. Molecular and mean field theory,Birefringence phenomena, polarizing microscopy, texture identifications and defects, Electric & Magnetic effects, Optical properties of liquid crystals. Liquid crystal composites:polymer and nano-materials dispersed liquid crystals composites, polymer liquid crystals, molecular dynamics between LCs and Dopants.Liquid crystal applications: present and future displays, manufacturing of LCDs, twisted nematic, super-twisted nematic, LED, IPS based displays and overview of LC in advance field's.

Recommended Books:

1. Introduction to Liquid crystal Chemistry and Physics: Peter J. Cooling and M. Hird, Taylor and Francis, (1997).
2. The physics of Liquid Crystals, P.G. De. Gennes, Oxford University Press, (1993).
3. Liquid Crystals, 2nd edition, S. Chandrasekhar, Cambridge University Press, (1992).
4. Liquid Crystal fundamental, S. Singh, D. A. Dunmur, World Scientific, (2002)
5. Handbook of Polymer Science and Technology, M. H. Ferry, CBS, Vol. 2 (2012)
6. Polymer Science, Gowarikar, Johan wiley and Sons, (1986)
7. Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House,(2002).