M.Sc. (PHYSICS)
Examination and Syllabus Scheme
(Credit and Grading System)

Course Code		Course Title	T/P	Credits	Evaluation(MM=100)	
					Internal	External
Programmer: BACHELOR (RESEARCH IN PHYSICS)						
First Semester						
PHY-101	Core	Mathematical Physics	T	4	25	75
PHY-102	Core	Classical Mechanics	T	4	25	75
PHY-103	Core	Electromagnetic Theory	T	4	25	75
PHY-104	Core	Quantum Mechanics	T	4	25	75
PHY-105	Practical	Related to Theory Papers	P	4	25	75
		Research Project/Dissertation		4		
Second Semester						
PHY-201	Core	Advanced Quantum Mechanics	T	4	25	75
PHY-202	Core	Condensed Matter Physics	T	4	25	75
PHY-203	Core	Atomic and Molecular Physics	T	4	25	75
PHY-204	Core	Electrodynamics and Plasma Physics	T	4	25	75
PHY-205	Elective	Minor Elective Paper from other faculty	T	4	25	75
PHY-206	Practical	Related to Theory Papers	P	4	25	75
		Research Project/Dissertation		4		
Programme: MASTER IN PHYSICS						
Third Semester						
PHY-301	Core	Lasers and Opto-electronics	T	4	25	75
PHY-302	Core	Nuclear Physics	T	4	25	75
PHY-303(S1)	Special	Electronics-I	T	4	25	75
PHY-304(S1)	Special	Electronics-II	T	4	25	75
PHY-303(S2)	Special	Biophysics-I: Cells and Genetic Information	T	4	25	75
PHY-304(S2)	Special	Biophysics-II: Macromolecules	T	4	25	75
PHY-303(S3)	Special	Solid State Physics-I: Crystallography and Imperfection In Crystals	T	4	25	75
PHY-304(S3)	Special	Solid State Physics-II: Characterization of Solids	T	4	25	75
PHY-305	Practical	Related to Theory Papers	P	4	25	75
		Research Project/Dissertation		4		
Fourth Semester						
PHY-401	Core	Statistical Mechanics	T	4	25	75

PHY-402	Core	High Energy Physics	T	4	25	75
PHY-403(S1)	Special	Advanced Electronics-I	T	4	25	75
PHY-404(S1)	Special	Advanced Electronics-II	T	4	25	75
PHY-403(S2)	Special	Biophysics-III: Methods and Techniques to Study Biological Systems	T	4	25	75
PHY-404(S2)	Special	Biophysics-IV: Theoretical Modeling of Biological Systems	T	4	25	75
PHY-403(S3)	Special	Solid State Physics-III: Special Solids, Surfaces & Properties	T	4	25	75
PHY-404(S3)	Special	Solid State Physics-IV: Many Particle Systems	T	4	25	75
PHY-405	Practical	Related to Theory Papers	P	4	25	75
		Research Project/Dissertation		4		

M.Sc. (Physics) First Semesters
PHY-101
Mathematical Physics

Credit-04

Unit-I Matrix Analysis

Definition of matrix, conjugate of a matrix, algebraic operation on matrices, rank of matrices, types of matrices, Hermitian and anti-Hermitian matrices, determinant of a square-matrix, inverse of a matrix, solution of linear equation, transformation matrices, diagonalization of matrix.

Unit-II Complex Variables

Definition of complex number, analyticity of complex function, Cauchy-Riemann condition, Cauchy's Integral theorem and formula, Zeroes, poles and singular points. Residue Theorem, Contour Integration.

Unit-III Tensors

Tensors, definition of a tensor in three dimensions and four dimensional space, rank of tensor addition, multiplication, contraction of tensors, Covariant and contra variant tensors. Pseudo tensors. Symmetry and anti-symmetric properties of tensor,.

Unit-IV Fourier Transformation & Polynomials

Fourier Transformation: Definition, Fourier series, FS for arbitrary period, Fourier Sine and Cosine transform, Application of Fourier-Transform.

Polynomials: Bessel and Legendre functions and polynomials, Rodrigue's formula for Legendre polynomial Orthonormality and other properties of Legendre, Associated Legendre, Hermit, Laguerre and Associated Laguerre polynomial.

Text and Reference Books:

1. Mathematical methods for Physicist: G. Artken
2. Mathematical Physics: Harper
3. Advanced Engineering Mathematics: Kreyazig
4. Elements of Complex variable: Churchill
5. Mathematical methods for Physicist and Engineers: K F Reilly, M P Hobsen

M.Sc. (Physics) First Semesters
PHY-102
Classical Mechanics

Credit-04

Unit – I

Mechanics of a system of particles, Generalized Co-ordinates, D Alembert's principle. The Lagrangian formulation and equations of motion (with full derivation). The Hamiltonian formulation and equations of motion (with full derivation).

Unit – II

Calculus of variations and its application–Hamilton's principle. The modified
Hamilton's principle and principle of least action, the rigid body motion–Euler angles, Motion of symmetrical top.

Unit – III

Canonical transformations, Poisson brackets, Equations of motion and infinitesimal canonical transformations in the Poisson bracket formulation, Liouville's theorem.

Unit – IV

Hamilton – Jacobi equations, Action angle variables, the connection between Hamilton-Jacobi theory and geometrical optics, Theory of small oscillations – Free vibrations of linear tri- atomic molecule.

Text and Reference Books:

1. Classical Mechanics: N C Rana & P S Joag, TMH 1991
2. Classical Mechanics: H Goldstein, Addison Wasley, 1980
3. Mechanics: A Sommerfield, Academic Press, 1952
4. Introduction to Dynamics: I Perceival & D Richards, Cambridge Unit Press, 1982

M.Sc. (Physics) First Semester
PHY-103
Electromagnetic Theory

Credit-04

Unit – I

Maxwell's Equations in vacuum and matter, Maxwell's correction to Ampere'slaw for non-steady currents and concept of Displacement current, Boundary conditions, Poynting's theorem, Conservation of Energy and momentum for asystem of charged particles and electromagnetic field.

Unit – II

Vector and scalar potentials, Maxwell's Equations in terms of Electromagnetic Potentials, Electromagnetic wave equation, Non-uniqueness of Electromagnetic Potentials and Concept of Gauge. Gauge Transformations: Coulomb and Lorentz Gauge; Green's Function for the Wave Equation, Transformation Properties of Electromagnetic Fields and Sources under Rotation, Spatial Reflection and Time-Reversal.

Unit – III

Propagation of Electromagnetic Plane Waves in Vacuum, Non-conducting Medium, Conducting Medium and Plasma; Reflection, Refraction and Polarizationof Electromagnetic Waves, Stokes Parameters; Frequency Dispersion Characteristics of Dielectrics and Conductors; Normal and Anomalous Dispersion, Spreading of Pulse in Dispersive Media, Kramer-Kronig Relations.

Unit – IV

Propagation of Electromagnetic Waves in Rectangular Waveguides, TE and TM Modes, Cut off frequency, Energy Flow and Attenuation. Modal Analysis of guided modes in a cylindrical waveguide. Field and Radiation due to an Oscillating Electric Dipole. Magnetic dipole and electric quadrupole fields.

Text and Reference Books:

1. Electromagnetic Theory by Julius Adams Start
2. Electromagnetic Theory: A Critical Examination of Fundamentals (formerly titled: Electromagnetics) (1938) by Alfred O'Rahilly
3. Electromagnetic Field Theory by V.A.Bakshi, A.V.Bakshi

M.Sc. (Physics) First Semester
PHY-104
Quantum Mechanics

Credit-04

Unit-I Fundamentals

Uncertainty principle and applications, Schrödinger wave equation, normalization, probability current density, expectation values, Ehrenfest theorem, energy Eigen function and Eigen values, hermitian operators and their properties, Orthonormality, free particle solution. One dimensional step potential (finite and infinite) particle in one dimensional square potential well (finite and infinite), linear harmonic oscillator, zero point energy, rectangular potential barrier.

Unit-II Three Dimensional System

Particle in three dimensional box, Dirac delta functions, orbital angular momentum, commutation relations, central force problems, solution of Schrödinger equation for spherical symmetric potentials, Hydrogen atom- reduced mass, wave function, energy levels, degeneracy, Energy Eigen function and Eigen values of three dimensional harmonic oscillator, and rigid rotator.

Unit-III Matrix Theory

Matrix, formulation of quantum theory, linear vector space, vector and operators and their matrix representation, bra and ket notations, projection operator, unitary transformation, matrix theory of linear harmonic oscillator, raising and lowering operators Eigen values and Eigen functions of L2 and Lx, spin, Pauli spin matrices, and their algebra, matrices for J2 and Jx, addition of two angular momenta, (elementary discussion).

Unit-IV Approximation Methods

Time independent perturbation theory for non degenerate case, formulation upto second order, perturbation of linear harmonic oscillator- (i) estimation of correction up to second order for perturbation term depending on x and x2 (ii) first order correction to energy by x3 and x4 type terms, Ground state of Helium atom, Stark effect of a plane rigid rotator.

Text and Reference Books:

1. Quantum Mechanics: L I Schiff, TMH
2. Quantum Mechanics: S gasioriwiez, Wiley
3. Quantum Mechanics: J D Powell, Addision Wiley
4. Quantum Mechanics: Mathews and Ventesan
5. Modern Quantum Mechanics: J J sakurai

M.Sc. (Physics) Second Semester
PHY-201
Advanced Quantum Mechanics

Credit-04

Unit-I

Variational method, Wentzel Kramer Brillouin (WKB) approximation, Time-dependent perturbation theory, Harmonic perturbation, Fermi's golden rule, Adiabatic and sudden approximation.

Unit-II

Collision in 3-D and scattering, Laboratory and CM reference frames, scattering amplitude, differential scattering cross section and total scattering cross section, scattering by spherically symmetric potentials, partial waves and Phase shifts, scattering by perfectly rigid sphere and by square well potential and absorption. Born approximation for scattering. Scattering by coulomb potential.

Unit-III

Identical particles, symmetric and anti symmetric wave functions, Collision of identical particles, Spin angular momentum, Spin function for a many electron system.

Unit-IV

Semi classical theory of radiation, Quantum Theory of radiation, Relativistic theory, The Klein-garden equation, The Dirac equation, covariance of Dirac equation, energy level of hydrogen atoms, hole theory and positrons.

Text and Reference Books:

1. L I Schiff, Quantum Mechanics (McGraw Hill)
2. S Gasiorowiez, Quantum Physics (Wiley)
3. B Craseman and J D Powell, Quantum Mechanics (Addison Western)
4. A P messiah, Quantum Mechanics
5. J J Sakurai, Modern Quantum Mechanics
6. Mathews and Venktesan, Quantum Mechanics

M.Sc. (Physics) Second Semester
PHY-202
CONDENSED MATTER PHYSICS

Credit-04

Unit-I Crystal Physics

Crystalline solids, unit cell and direct lattice, Miller indices of planes and axes, two and three dimensional Bravais lattices, closed packed structures, Braggs law, experimental diffraction techniques, construction of reciprocal lattice, reciprocal lattice vector, Brillouin zone and atomic factor.

Unit-II Point Defect and Imperfection

Point defect, line defect and planer stacking fault, the role of dislocation in plastic deformation and crystal growth, the observation of imperfection in crystal, X-ray and electron microscopic techniques.

Unit-III Electronic Energy Bands

Electrons in periodic lattice, Bloch theorem, Band theory, classification of solids, effective mass, tight binding, cellular and pseudo potential method.

Unit-IV Superconductivity

Superconductivity: Critical temperature, persistent current, Meissner effect, type I and type II superconductors, heat capacity, energy gap, isotopic effect, London's equation, coherent length.

Text and Reference Books:

1. Verma and Shrivastava: Crystallography for Solid State physics
2. Aschroff and Mermin: Solid State physics
3. Kittel: Solid State physics
4. Chaikin and Lubensky: Principles of Condensed Matter Physics
5. Dekker: Solid State physics

M.Sc. (Physics) Second Semester
PHY-203
ATOMIC AND MOLECULAR PHYSICS

Credit-04

Unit-I Atomic Physics

Quantum states of one-electron atoms, atomic orbital, hydrogen spectrum, Pauli's principle, spectra of alkali elements, spin orbit interaction and fine structure in alkali spectra-equivalent, non-equivalent electrons.

Unit-II Atomic Spectra

Normal and anomalous Zeeman effect, Paschen Back effect, stark effect, two electron system, interaction energy in LS and JJ coupling, hyperfine structure (qualitative).

Unit-III Diatomic-Molecular Spectra

Rotational spectra of diatomic molecules as a rigid rotator, Energy levels and spectra of non-rigid rotator, Intensity of spectral lines.

Unit-IV Energy of Molecules

Vibrational energy of diatomic molecules, diatomic molecules as a simple harmonic oscillator, Energy level and spectrum, Mores potential energy curve, Molecules as vibrating rotator, vibrational spectrum of diatomic molecules, PQR branches.

Text and Reference Books:

1. Introduction to atomic spectra, H E White (T)
2. Fundamental of molecular spectroscopy, C W Banwell (T)
3. Spectroscopy Vol I II III, Walker and Straughen
4. Introduction to molecular spectroscopy, G M Barrow
5. Spectra of diatomic molecules, Herzberg

M.Sc. (Physics) Second Semester
PHY-204
Electrodynamics and Plasma Physics

Credit-04

Unit-I Retarded Potentials

Retarded potential and Lienard-Wiechert potential, electric and magnetic fields due to a uniformly moving charge and an accelerated charge, Linear and circular acceleration and angular distribution of power radiated Bremsstrahlung, synchrotron radiation and cherenkov radiation, reaction force of radiation.

Unit-II Motion of Charged Particles

Motion of charged particles in electromagnetic field: Uniform E and B fields, non- uniform magnetic fields, diffusion across magnetic field, time varying E and B fields, adiabatic invariants: first, second and third adiabatic invariants.

Unit-III Basics of Plasma

Elementary concepts: Derivation of moment equations from Boltzmann equation, plasma oscillations, Debye shielding, plasma parameters, magnetoplasma, plasma confinement, hydro dynamical description of plasma, fundamental equations, hydromagnetic waves, magnetosonic and Alfven waves.

Unit-IV Wave Propagation

Wave phenomena in magnetoplasma: Polarization, phase velocity, group velocity, cutoffs, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field, Appleton-Hartree formula.

Text and Reference Books:

1. Panofsky & Phillips: Classical electricity and magnetism
2. Bittencourt: Plasma Physics
3. Chen: Plasma Physics
4. Jackson: Classical electrodynamics

M.Sc. (Physics) Third Semester
PHY-301
Lasers and Opto-Electronics

Credit-04

Unit-I

Laser theory, Einstein Coefficients, Light Amplification, threshold condition, Laser Rate Equations-two, three and four level systems.

Unit-II

Laser power around threshold, optimum output coupling, Line Broadening Mechanisms – Natural, Collision and Doppler, Optical Resonators – Modes of a rectangular cavity and open planar resonator, Modes of a Confocal resonator system, General Spherical resonator, Higher order modes.

Unit-III

Essential criterion to observe non linear optical effects. First experimental demonstration of non-linear phenomena. Classical theory of non-linear response in one dimension. Generalization to 3 dimensions.

Unit-IV

Non-linear coupling of 3 waves to produce sum and difference frequencies. Manley Rowe relations and their significance. Sum and difference frequency generation when both input frequencies are lasers. Parametric conversion and amplification.

Text and Reference Books:

1. Svelto: Lasers
2. Yariv: Optical Electronics
3. Demtroder: Laser Spectroscopy
4. Latekhov: Non linear Spectroscopy
5. Robert Boylested and Louis Nashdsky: Electronic devices and circuit theory, PHI, New Delhi
6. Ramakanth A Gayakwad: OP amps & linear integrated circuits, PHI second addition, 1991
7. Jacob Millman: Microelectronics, Mc-Hill international book co, New Delhi, 1990
8. Alien Chappa

M.Sc. (Physics) Third Semester
PHY-302
Nuclear Physics

Credit-04

Unit – I

Basic facts about nuclei, Mass and binding energy, Semi-empirical mass formula, Nuclear size determination using mu-mesic X-rays and scattering of fast electrons, Nuclear spin and magnetic moment of nuclei, Molecular beam resonance method, Nuclear resonance absorption and induction method, Electric quadrupole moment

Unit – II

Alpha decay, Experimental results on alpha decay-Alpha spectra and Geiger-Nutall relation, Theory of alpha decay. Beta-spectra, Fermi's theory of beta decay, Sergeant's law, Kurie Plot, Allowed and forbidden transitions, Parity violation in beta-decay, Detection of neutrino.

Unit III

Gamma emission, Multipolarity of gamma rays, Selection rules, Theoretical prediction of decay constants, Estimation of Transition probabilities, Internal conversion, Angular correlation, Nuclear isomerism, Mossbauer Effect.

Unit – IV

Nuclear reactions, Conservation laws, The Q-equation and deduction of nuclear energy levels, Compound nucleus, Bohr hypothesis, Resonance phenomena, Breit- Wigner one level formula, Optical model, Simple discussion of direct reactions, Nuclear fission, Bohr-Wheeler theory of nuclear fission, Controlled chain reaction, Nuclear reactors.

Text and Reference Books:

1. Ghosal: Atomic and Nuclear physics, vol 2
2. D Griffiths: Introduction to elementary particles, Harper and Row, New York, 1987
3. H A Enge: Introduction to nuclear physics, Addison Wesley, 1975
4. S de Benedeti: Nuclear interaction, John Wiley & Sons, New York, 1955
5. M K Pal: Theory of nuclear structure affiliated East- West, Madras, 1982.

M.Sc. (Physics) Third Semester
PHY-303 (S1)
Electronics-I
(Electronics Devices and Circuits)

Credit-04

Unit-I Linear Wave Shaping

High Pass and Low Pass RC Networks, Response to Sinusoidal, Step, Pulse, Square wave, Exponential and Ramp Inputs. High pass RC circuit as a differentiator, Criterion for good differentiation, Double Differentiation, Low Pass RC circuit as an Integrator. Laplace Transforms and their application to circuit elements.

Unit-II Amplifiers

Difference Amplifiers, Broadband Amplifiers, Methods for achieving Broadbanding, Emitter Follower at High Frequencies, Operational Amplifiers and its Applications, IC 741, Active Filters.

Unit-III Power Supplies

Electronically Regulated Power Supplies, Converters and Inverters, High and Low Voltage Supplies, Switched Mode Power Supply (SMPS).

Unit-IV Integrated Circuit Fabrication Technology

Basic Monolithic Integrated Circuits, Steps involved in the Manufacture of Monolithic ICs: Epitaxy, Masking, Etching, Diffusion, Metallization, Bonding, Assembling, Package types. Introduction to VLSI techniques.

Text and Reference Books:

1. Robert Boylested and Louis Nashdsky: Electronic devices and circuit theory, PHI, New Delhi
2. Ramakanth A Gayakwad: OP amps & linear integrated circuits, PHI second addition, 1991
3. Jacob Millman: Microelectronics, Mc-Hill international book co, New Delhi, 1990
4. Alien Chappal: Optoelectronics- theory and practice, Mc-Hill international book co, New York

M.Sc. (Physics) Third Semesters
PHY-304 (S1)
Electronics-II
(Digital Electronics)

Credit-04

Unit-I Logic Hardware

Transistor as a Switch, Switching times: Definition and Derivation, Storage Time, Delay Time, Turn On Time, Turn Off Time, Charge Control Analysis. Logic Specifications: Fan In, Fan Out, Noise Immunity, Noise Margin, Propagation Delay, Power Dissipation. Logic Families: DTL, DCTL, I2L, ECL, TTL, CMOSL, CML, HTL.

Unit-II Number Systems and Boolean Algebra

Binary, Octal and Hexadecimal Number Systems. Binary Arithmetic. Arithmetic Circuits. Binary Codes: Gray, 8421, 2421, 5211. Boolean Variables and Operations, Simplification of Boolean Expressions. Karnaugh Maps.

Unit-III Multivibrators

Astable, Monostable and Bistable Multivibrators. Schmitt Trigger. 555 Timer. SR, JK, T and D, J Master Slave Flip flops, Race problem and Edge Trigger JK Flip flop, Preset and Clear Functions.

Unit-IV Counters and Registers

Binary Counters:. Modulus of Counters: Asynchronous and Synchronous Counter Reset Method, Logic Gating Method. Ring Counter. Shift Registers: SISO, PIPO, SIPO, PISO. Universal Shift Register. Tristate Switches, Tristate Registers.

Text and Reference Books:

1. Barrey B Brey: The internal microprocessors 8086/8088, 80186, 80286, 80386, 80486 pentium andPentium processors architecture, programming interfacing, IVth edn. 1999.
2. Douglas V Hall: Microprocessors and interfacing, programming and hardware, IInd edn. Mc-GrawHill, 1992.
3. M A Maxidi and J G Mazidi: The 80x86 IBM PC and compatible comp. (Vol. I & II), IInd edn.Prentiee-Hall international, 1998.

M.Sc. (Physics) Third Semesters
PHY-303 (S2)
Biophysics-I
(Cells and Genetic Information)

Credits: 04

Unit-I DNA

Double helical structure of DNA, Watson-Crick model of DNA, Conformational parameters of nucleic acids and their constituents, Nucleosides and nucleotides, primary, secondary and tertiary structure of DNA, backbone conformation, sugar puckering, B, A and Z types of DNA, DNA super coiling.

Unit-II RNA

Structure of RNA, different forms of RNA and their biological functions.

Unit-III Cells

Introduction to the cells, cell organelles, cell types and cell functions, structures and functions of neurons, neurotransmitters.

Unit-IV Transfer of genetic information

Replication, transcription, reverse transcription and protein synthesis, DNA replication, RNA transcription and protein biosynthesis, reverse transcription, mutation and regulation of genes, genetic code.

Text and Reference Books:

1. P. Narayanan “Essentials of Biophysics” New Age International, 2000.
2. P. Nelson “Biological Physics; Energy, Information, Life” W.H. Freeman, 2003.
3. Meyer B Jackson “Molecular and Cellular Biophysics” Cambridge University Press, 2006.
4. P K Banerjee “Introduction to Biophysics” S Chand Publishing, 2010.
5. W. Saenger “Principles of Nucleic Acid Structure” Springer Verlag, New York 1983.
6. V. Pattabhi & N. Gauttam “Biophysics” Narosa Publishing House, 2002.

M.Sc. (Physics) Third Semester
PHY-304 (S2)
Biophysics-II
(Macromolecules)

Credits: 04

Unit-I Proteins

Amino acids, primary, secondary, tertiary and quaternary structures of proteins, properties of amino acids, protein-folding, protein conformation, torsion and dihedral angles, Ramachandran map, structure of heamoglobin and myoglobin.

Unit-II Sugars

Sugars, structures of sugars, role of sugars in biological systems, ATP and ADP, energetics, photosynthesis.

Unit-IV Carbohydrates and Lipids

Monosaccharides, Disaccharides, Polysaccharides, Glycoproteins, classification and structures of lipids, Membranes, Membrane structures, Membrane fluidity and membrane proteins.

Unit-III Enzymes

Enzymes, mechanism of enzyme action, enzyme kinetics, effects of temperature and pH, Lock and Key model, Induced-fit model, Conformations.

Text and Reference Books:

1. P. Narayanan “Essentials of Biophysics” New Age International, 2000.
2. P. Nelson “Biological Physics; Energy, Information, Life” W.H. Freeman, 2003.
3. Meyer B. Jackson “Molecular and Cellular Biophysics” Cambridge University Press, 2006.
4. P. K. Banerjee “Introduction to Biophysics” S Chand Publishing, 2010.
5. W. Saenger “Principles of Nucleic Acid Structure” Springer Verlag, New York 1983.
6. V. Pattabhi & N. Gauttam “Biophysics” Narosa Publishing House, 2002.

M.Sc. (Physics) Third Semester
PHY-303 (S3)
Solid State Physics -I
(Crystallography and Imperfection In Crystals)

Credits: 04

Unit-I

Miller indices, Diffraction of X-rays by crystals, Scattered wave amplitude-Fourier Analysis, Reciprocal Lattice Vectors, Diffraction Condition , Laue Equation, Brillouin Interpritation. Principal of powder diffractometer, Interpretation of powder-photographs. Analytical indexing: Ito's method. Application of powder method.

Unit-II

Interpretation of oscillation photograph, X-ray method of orienting crystals about a crystallographic direction. Bernal chart, Indexing of reflection. Fourier representation of electron density, the phase problem, Patterson function.

Unit-III

Mechanism of plastic deformation in solids, stress and strain fields of screw and edge dislocations, elastic energy of dislocation, forces between dislocations, stress needed to operate Frank-Read source. Partial dislocations and stacking faults in close-packed structures.

UNIT-IV

Basic features of Piezo, Pyro and Ferro Electric Material, order-disorder and displacive type ferro electric materials, Occurrence of Ferro electricity due to polarization catastrophe and lattice modes , Devonshire Theory of ferroelectric phase transition.

Text and Reference Books:

1. Crystallography for Solid State Physics: Verma and Srivastava
2. X-ray Crystallography: Leonid V. Azaroff.
3. Elementary Dislocation Theory: Weertman andWeertman
4. Crystal Structure Analysis: R. Buerge.
5. Electron Microscopy of Thin Crystals: Peter B. Hirsh

M.Sc. (Physics) Third Semester
PHY-304 (S3)
Solid State Physics -II
(Characterization of Solids)

Credits: 04

Unit-I

Linearised Boltzmann transport Equation , Electrical Conductivity, Relaxation time, Impurity scattering, Ideal resistance, Carrier mobility, General transport coefficient, Thermal Conductivity, Themoelectric effects, Lattice Conduction. Phonon Drag, Hall effect and Magnetoresistance.

Unit-II

Elementary Concepts of Scanning and Scanning Tunneling Microscopic Techniques (SEM, STM) X-ray Photoelectron Spectroscopy (XPS/ESCA) for chemical analysis. RBS (Rutherford Back Scattering) and SIMS (Secondary Ion Mass Spectroscopy). Defect related electronic states characterization by C-V characteristics of electronic junction devices,
Temperature stimulated current and capacitance (TSC/TSCAP), Deep Level Transient Spectroscopy (DLTS), Electronic Beam Induced Current (EBIC) and Light Beam Induced Current (LBIC).

Unit-III

Double Beam IR Spectrometers, Basic Concepts of Raman Spectroscopy in Solids, Sensitive Detectors such as CCD Camera, Concept of Space Group and Point Group, Identification and Analysis of Optic and Acoustic Modes in Solids. Electronic Absorption Study for Band Gap Determination.

Unit-IV

General theory of magnetic resonance and Bloch equation, Electron paramagnetic resonance, Structure of Resonance lines and their uses, Nuclear magnetic resonance: Salient theory and method of observation, structure of resonance lines and their uses.

Text and Reference Books:

1. Analytical Techniques for Thin Film-Treatise on Material Science and Technology, Vol. 27: K.N. Tu and R. Rosenberg (ed.).
2. Electron Microprobe Analysis: S.J. B. Reed.
3. Topics in Applied Physics, Vol. 4: R. Gomer (ed.).
4. Principle of Magnetic Resonance : C.P Slicher

M.Sc. (Physics) Fourth Semesters
PHY-401
Statistical Mechanics

Credit-04

Unit-I Basics of Statistical Mechanics

Foundation of statistical mechanics, specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox, phase space, trajectories and density of states, Liouville's theorem.

Unit-II Ensemble Theory

Micro-canonical, canonical and grand canonical ensembles, partition functions, calculation of statistical quantities.

Unit-III Statistics

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

Unit-IV Ising Model

Cluster expansion for a classical gas, virial equation of state, ising model, mean fieldtheories of ising model in one, two and three dimensions, exact solution in one dimension.

Text and Reference Books:

1. F Rief: Statistical and Thermal physics
2. K Huang: Statistical mechanics
3. R K Patharia: Statistical mechanics
4. R Kubo: Statistical mechanics
5. Landau and Lifshitz: Statistical mechanics

M.Sc. (Physics) Fourth Semester
PHY-402
High Energy Physics

Credit-04

Unit-I

Nuclear two-body problem, Simple theory of deuteron, Spin dependence and non-centrally feature of nuclear forces, Partial wave analysis, Low energy n-p scattering, Scattering length and effective range theory, Low energy p-p scattering, Charge symmetry and charge independence of nuclear forces, Meson theory of nuclear forces.

Unit-II

Nuclear models, Evidence of shell structure, magic numbers and spin-orbit coupling, extreme single particle model. Predictions of spin, parity and electromagnetic moments, Collective model-Vibrational and rotational spectra.

Unit-III

Classification of elementary particles, Exact conservation laws, Approximate conservation laws: isospin and isospin wave functions for pion-nucleon system, strangeness, parity, time reversal and charge conjugation, CP violation.

Unit-IV

Eight fold way, Quarks, Quark-Quark interaction, SU (3) quark model, Magnetic dipole moment of baryons, Masses of hadrons, Basic ideas about the standard model.

M.Sc. (Physics) Fourth Semester
PHY-403 (S1)
Advanced and Digital Electronics-I
(Analog and Digital Communication)

Credit-04

Unit-I Amplitude Modulator

Amplitude Modulation, Spectrum of the modulated signal, Square law Modulator, Balanced Modulator, DSBSC, SSB and vestigial sideband modulation. Limitations of Amplitude Modulation. AM Receiver.

Unit-II Frequency Modulator

Analysis and frequency Spectrum, Generation and Detection of FM. Comparison of AM and FM. Pre-emphasis and De-emphasis. Reactance Modulator. Capture Effect. Varactor Modulator. Amplitude Limiter. FM Receiver. Foster Seely Discriminator. Ratio Detector.

Unit-III Radar & Television

Radar: Principle of radar, Elements of radar system, Peratind characteristics and maximum range of radar set, Duplexer, Radar beacons.
Television: General principle of image transmission scanning sequence and synchronization, Television camera tubes, elements of color television.

Unit-IV Microwave and Digital Communication

Microwave Generator: High frequency generation problems, Klystron amplifier and oscillators, Gunn oscillator and microwave components.
Digital Communication: Sampling theorem, Pulse Modulation: Pulse Code, Pulse Amplitude, Pulse Position Pulse Width Modulation. Differential PCM, Delta Modulation. Digital Communication System. Digital Carrier System. Frequency Shift Keying. Phase Shift Keying. Differential Phase Shift Keying. Division Multiplexing.

Text and Reference Books:

1. Wayne Tomasi: Advanced electronics communications systems, Phi. Edn.
2. Taub and Schilling: Principles of communication systems, second edition TMH, 1990
3. Simon Haykin: Communication systems, third edition, John Wiley and sons, Inc., 1994

M.Sc. (Physics) Fourth Semesters
PHY-404 (S1)
Advanced Electronics-II
(Logic Circuits, Memories, Converters, Microprocessors)

Credit-04

Unit-I Combinational Logic Circuits

Pin out Diagrams, Truth Table and Working. Decoders: 1-of-4 IC 74AS139, 1-of-16 IC 74154 BCD to Decimal Decoder IC 7445, BCD to Seven Segment Decoder Driver: IC 7447A, 7448.Encoders: Decimal Priority Encoder IC 74147 Multiplexers, Implementation of Boolean Function using multiplexer, Demultiplexers: Demultiplexeral Decoder.

Unit-II Memories

Memory Devices: Read Only Memories, Masked Memory, ROM, Programmable ROM, EPROM. Random Access Memory: Static and Dynamic, Bipolar Ram Cell, Static RAM cell.

Unit-III A/D and D/A Converters

Binary weighted Resistor D/A Converter, Ladder Network D/A Converter. D/A Converter Specifications: Resolution, Accuracy, Linearity, Settling Time, Temperature Sensitivity. Flash A/D Converter, Ramp A/D Converter, Successive Approximation A/D Converter.

Unit-IV Microprocessors and Displays

LED Displays: Common Anode Display FND 507, FND 567.Common Cathode Display FND 500, FND 560. Flat Panel Displays (LCD, Plasmas etc.) and their addressing techniques. Smart Windows. Intel Microprocessors: Historical Perspective. Architecture of Microprocessor 8085: Addressing modes and Instruction Set of 8085. Programming examples.

Text and Reference Books:

1. Barrey B Brey: The internal microprocessors 8086/8088, 80186, 80286, 80386, 80486 pentium and Pentium processors architecture, programming interfacing, IVth end. 1999.
2. Douglas V Hall: Microprocessors and interfacing, programming and hardware, IInd end. McGraw Hill, 1992.
3. M A Maxidi and J G Mazidi: The 80x86 IBM PC and compatible comp. (Vol. I & II), IInd end. Prentiee-Hall international, 1998.

M.Sc. (Physics) Fourth Semester
PHY-403 (S2)
Biophysics-III
(Methods and Techniques To Study Biological Systems)

Credits: 04

Unit-I Spectroscopic Techniques

Elementary idea about UV/VIS, Absorption, Raman, Fluorescence and NMR spectroscopic techniques, study of biological Systems using spectroscopic techniques.

Unit-II Imaging and Diffraction Techniques

Imaging techniques, Ultrasonography (USG), Magnetic Resonance Imaging (MRI). Computed tomography (CT) scan and Positron emission tomography. Elementary Idea of Production and Characteristics of X-ray, Applications of X-ray Diffraction, Neutron Diffraction and Electron Diffraction to Biological Systems.

Unit-III Diffusion and Electro-analytical Techniques

Diffusion, Chromatography and Gel Electrophoresis, pH Measurement

Unit-IV Bulk and Surface Techniques

Polarimetry, Optical Rotary Dispersion (ORD), Circular Dichroism (CD), Light Scattering and Size of Aggregates, Applications of Electron Microscopy to Biological Systems.

Text and Reference Books:

1. P. Narayanan “Essentials of Biophysics” New Age International, 2000.
2. V. Pattabhi & N. Gauttam “Biophysics” Narosa Publishing House, 2002.
3. P. Nelson “Biological Physics; Energy, Information, Life” W.H. Freeman, 2003.
4. B. Nolting “Methods in Modern Biophysics” Springer, 2005.
5. K. Wilson and J. Walker “Principles and Techniques of Practical Biochemistry” 5th Edition, Cambridge University Press, 2000.

M.Sc. (Physics) Fourth Semester
PHY-404 (S2)
Biophysics-IV
(Theoretical Modeling Of Biological Systems)

Credits: 04

Unit-I Quantum Chemical Methods and Related Concepts

Born-Oppenheimer approximation, Concept of molecular orbitals, Hartree-Fock theory, semi-empirical and ab-initio methods, density functional theory, tautomers, intermolecular interactions, potential energy surfaces, molecular recognition, electron density distribution, electrostatic potential, solvent effect, stacking interactions, molecular mechanics.

Unit-II Chemical Kinetics

Chemical reaction, transition state theory, rate constants.

Unit-IV Statistics of Biopolymers

Elements of statistical mechanics, molecular weight averages, end-to-end distance, radius of gyration, interaction among polymer segments & solvent molecules and its effect on the end-to-end distance, lattice model of polymers and its application to coil-globule transition in polymers, protein folding and DNA melting.

Unit-V Mechanics of Biopolymers

Structural and elastic properties of DNA and proteins, Force-induced transitions in biopolymers and their modeling.

Computer Simulation

Monte Carlo and molecular dynamics simulations, Algorithms and simple applications.

Text and Reference Books:

1. I.N. Levine “Quantum Chemistry” Prentice-Hall, 1994.
2. W.J. Hehre, L.Radom, P.V.R. Schleyer, J.A. Pople “Ab Initio Molecular Orbital Theory” John Wiley, 1986.
3. R. McWeeny “Coulsons’s Valence” Oxford University Press 1980.
4. D. Frenkel and B. Smit “Understanding Molecular Simulation” Academic Press 2002.
5. P. Nelson “Biological Physics; Energy, Information, Life” W.H. Freeman, 2003.

M.Sc. (Physics) Fourth Semester
PHY-403 (S3)
Solid State Physics -III
(Special Solids, Surfaces & Properties)

Credits: 04

Unit-I

Structure and symmetries of liquids, liquid crystals and amorphous solids. Liquid Crystals: Definition, Classification, Characteristic features: Thermotropic and Lyotropic Liquid Crystals, FLCs, Basic Principle of LCDs.

Unit-II

Difference of behavior of thin films from bulk. Boltzmann Transport equation for a thin film. Determination of distributing function for thin films and qualitative estimates of electrical conductivity. Scanning tunneling and Atomic Force Microscopy.

Unit-III

Weins theory of ferromagnetism, Molecular field theory. Heisenberg explanation of internal magnetic field, Landau theory of Domain, Spin-wave theory, Magnon excitation and Bloch T3/2 law, Antiferromagnetism, Ferrimagnetism, Neels Two sub-lattice model.

Unit-IV

Polymers: Structure, Properties and Method of Polymerization, Degration of Polymers, Viscoelectric State, Glass transition temperature.

Nano-Materials: Definition , Types and characteristic features, Quantum size effect, density of states, Synthesis and characterization of Nanocomposites .

Text and Reference Books:

1. Liquid Crystals: S Chandrashekhar
2. An Introduction to Polymer Physics: I. I. Perepechko
3. Physics of Thin Films: K.L. Chopra
4. Nanotechnology: Principle and Practices: S K Kulkarni

M.Sc. (Physics) Fourth Semester
PHY-404 (S3)
Solid State Physics-IV
(Many Particle Systems)

Credits: 04

Unit-I

Basic features of Superconductors: Zero resistance, Meissner Effect, Penetration Depth, Critical Field, Heat capacity and Isotopic shift. Soft and Hard superconductors, Thermodynamics of superconducting transitions, London equation, Coherent length, Particle tunneling and Josephson effect.

Unit-II

Interaction of Electron with Acoustic and Optical Phonons, Cooper Pairing due to Phonon, BCS Theory of Superconductivity, Ginzberg-Landau Theory of Superconductivity and Application to type II superconductors, Vortices and Abrikosov Phase. Charge transfer model of Cuprates.

Unit-III

Interactions of Electrons and Phonons with Photons, Elementary ideas on Direct and Indirect Transitions, Polaritons. Electron Localiztion in Disordered System: Electron Localization, Density of States, Mobility Edge, Anderson Localization, Hopping Conductivity.

Unit-IV

Difficulties in observing resonance fluorescence of nuclear system, Recoil energy, Natural and dipole broadening , Classical and Quantum theories of Mossbauer effect, Experimental method and principle uses of Mossbauer effects.

Text and Reference Books:

1. Principle of theory of solid: J M Ziman
2. Theoretical Solid State Physics: W. Jones and N H March
3. Principle of Magnetic Resonance: C.P Slicher
4. Mossbauer Effect and its Application: V. G. Bhinde

M.Sc. Physics, Semesters VII &VIII Practical
(List of Experiments)

Electronics Group Practicals

1. Hysteresis Curve (a) by Ballistic method
   (b) by Oscillograph
2. FET/MOSFET Characteristics
3. Ultrasonic Diffraction
4. Michelson Interferometer
5. Elastic constant by Newton's Ring
6. Hall Effect
7. Use of constant deviation spectrograph
8. Q of coil
9. Planck's constant
10. Richardson Equation
11. GM Counter
12. Energy band gap of semiconductor
13. Fourier analysis by CRO
14. Experiment on Laser
15. Transistor Characteristics

Biophysics group Practicals

1. Optimization of structures of N9H and N7H tautomers of guanine. Comparison of total energies.
2. Optimization of normal structure of lysine in gas phase and zwitterionic structure in aqueous media.
3. Optimization of geometries of cis- and trans-conformers of 2′-deoxyadenine.
4. Study of infrared spectrum of adenine experimentally and theoretically.
5. Determination of surface tension of a given biopolymer (agarose).
6. Molecular geometry optimization of cystein and cystine.
7. Study of Ramachandran diagrams of mono and dipeptides.
8. Absorption and fluorescence spectra of tryptophan.
9. Separation of DNA and estimation of the size of DNA molecules by Agarose gel electrophoresis.
10. Determination of different constants/exponents associated with biopolymers.

Solid State Physics Group Practicals

1. Measurement of lattice parameter and indexing of powder photograph
2. Identification of unknown sample using powder diffraction method.
3. To study the ferroelectric transition in TGS crystal and measurement of Curie temperature
4. To measure the superconductivity transition temperature and transition width of a high temperature superconductor
5. Rotation / oscillation photograph and their interpretation

M.Sc. Physics, Semesters IX & X Practical

(List of Experiments)

Electronics Group Practicals

1. Study of RC Coupled Amplifier
2. Negative Feedback Amplifier
3. Study of Multivibrator
4. Study of Oscillators
5. Amplitude Modulation & Demodulation
6. NAND and NOR gate as universal gate.
7. D/A and A/D Convertor
8. Characteristics of Operational Amplifier
9. Operational Amplifier as inverting, non-inverting, D-summing Amplifier
10. Study of time 555
11. Series regulated power Supply
12. Multiplex & Demultiplexs,
13. Study Incoders and decoders and BCD to saving segment.
14. Microprocessor
15. Verification of AND, OR, and NAND logic Gates.

Biophysics group Practicals

1. Computer simulation of Coil-Globule transition in biopolymers.
2. Computer simulation of thermal denaturation of DNA.
3. Electronic spectra (UV absorption and fluorescence) of adenine.
4. Electronic spectra (UV absorption and fluorescence) of guanine.
5. Extraction of urease from Cajanus indicus and determination of its activity.
6. Separation of Protein and estimation of the size by Agarose gel electrophoresis..
7. Spectroscopic study of chlorophyll extracted from natural sources.
8. Theoretical study of electronic spectra of adenine and guanine.
9. Electronic spectra (UV absorption and fluorescence) of phenylalanine.
10. Electronic spectra (UV absorption and fluorescence) of tyrosine.

Solid State Physics group Practicals

1. To study the modulus of rigidity and internal friction in a metal as a functioning temperature.
2. To measure the Cleavage step height of a crystal by multiple Fizeau Fringes.
3. To determine magnetoresistance of a Bismrith crystal as a function of magnetic field.
4. Synthesis/ Fabrication of Carbon Nanotubes by spray paralysis method and its verification through X-ray diffraction.
5. To build crystal structures and to calculate its powder diffraction pattern using material Studio software and to analyze structures and diffraction patterns.

M.Sc. (Physics) Second Semester
PHY-205 (S1)
Elective Paper (Basic Solid State Physics)

Credits: 04

Unit-I

Basis and lattice, Unit Cell, Bravais Lattice in two dimension, Cubic Crystals: SC, BCC and FCC, Coordination Number, Miller Indices, Spacing between lattice planes, Nacl and dimond crystal structures.

Unit-II

Braggs Law, Experimental diffraction methods-Rotating Crystal method and powder method, Reciprocal Lattice vector and their properties, Reciprocal lattice of simple cubic, base center cubic and face center cubic lattice.

Unit-III

Ionic Crystals, Madelung energy, evaluation of Madelung Constant, Free electron theory, Fermi energy, Hall Effect in Metal, Origin of Band Theory, Effective Mass of Electron.

UNIT-IV

Superconductivity, Properties of Superconductor, Meissner Effect, Type I and Type II Superconductor, Isotope Effect, London Equation, Penetration Depth, Coherence Length.

Text and Reference Books:

1. Crystallography for Solid State Physics: Verma and Srivastava
2. Solid State Physics: Kittel.
3. Crystal Structure Analysis: R. Buerge.

M.Sc. (Physics) Second Semester
PHY-205 (S2)
Elective Paper (Basic Electronics)

Credits: 04

Unit-I

Semiconductor, Intrinsic Semiconductor, Extrinsic Semiconductors, Working of p-n junction in unbiased forward and reverse bias, Formation of depletion layer, Biasing of p-n junction, V-I characteristics of p-n junction diode in forward and reverse bias.

Unit-II

Avalanche and Zener breakdown, Static and Dynamic resistance of a diode, Zener Diode, Zener diode as voltage regulator, Light emitting diode, Photo Diode, Tunnel Diode.

Unit-III

Half wave rectifier, Full wave rectifier, Bridge Rectifier, Series Inductor Filter, Shunt Capacitor Filter, L-section Filter, Pie-section Filter, Power Supply.

Unit-IV

Transistor Terminals, Working of p-n-p and n-p-n transistors, Characteristics of transistor in common Base and Common Emitter configuration, Current amplification factors and relation between them, current gain, voltage gain and power gain.

Text and Reference Books:

1. B .G. Streetman: Solid state Electronic Devices.
3. W. D. Stanley: Electronic Devices Circuits and Application.
4. J. D .Ryder: Electronics Fundamentals and Applications.

M.Sc. (Physics) Second Semester
PHY-205 (S3)
Elective Paper (Atomic and Molecular Physics)

Credits: 04

Unit I

Bohr Theory and Spectra of hydrogen, Space quantization and electron spin hypothesis, Stern Gerlach Experiment, Various quantum numbers of an electron relating to Vector Model of Atom, Spin- Orbit interaction Energy.

Unit-II

Spectral terms for Alkali Atoms, Doublet fine structure, Singlet and Triplet fine structure in Alkaline earth Spectra, LS and JJ couplings, Determination of spectral terms for both coupling Schemes Selection Rule.

Unit-III

Continuous X-rays Spectrum, Duane and Hunts Law, Characteristics X-rays, Moseley Law, Doublet structure of X-rays Spectra, X-rays Absorption Spectra.

Unit-IV

Vibration, Rotational and rotational–vibration Spectra of Molecules, Dissociation Limit for ground and other electronic states, Stokes and Anti-Stokes Line, Raman Effect.

Text and Reference Books:

1. H. E. White: Introduction to Atomic Spectra
2. C. N. Banwell & E.M.McCash: Fundamental of Molecular Spectroscopy
3. Hertzberg: Molecular Spectra

Pre-Ph.D. Course Work Syllabus Physics

Maa Vindhyavasini University, Mirzapur

Pre-Ph.D. Course Work Syllabus
Paper - I
RESEARCH METHODOLOGY

Unit- I

Definition of research, research hypothesis, objective & basic principles of research, motivation in research, meaning of research methodology, difference(s) between methods of research & research methodology. Research approaches and related tools, Types of research, significance of research, qualities of researcher, components of research problem, various steps in scientific research, research purposes, research design, overview of research, literature survey, research process in flow chart, conditions and criteria for good research. Importance of communication skill in research-development of power of expression in both speaking and writing, presentation techniques. Progress-report writing on the research topic(s). The dilemmas and the decision–makings the reality.

Unit- II

Fundamentals of computers Computer fundamentals, hardware and software, different operating systems, application programmes, Computer application for research, Word Processing, Excel, Power Point, Data Processing, Use of Web-2 tools for research, use of Graphical Software, Use of Multimedia Tools, Structure and Components of Research Report, Report writing, Seminar, Presentation. Types of Report: research papers, thesis. Research Project Reports, Pictures and Graphs, citation styles.

Unit- III

Working in a Linux environment, basic Linux commands, writing scientific documents with Latex, graphic and visualization, gnu plot; introduction to other useful software tools e.g. Mathematica computer programming. Difference between TEX and LATEX, basics of using latex, latex input files, input file structures, layout of the document, titles, chapter and sections, cross references, foot note, environments, typesetting, building blocks of a mathematical formula, matrices, tables, including encapsulated postscript graphics, bibliography, downloading and installing LATEX packages. Introduction to origin, basics of importing and exporting data, working with Microsoft excel, graphing, statistics in origin, basic linear regression and curve fitting, Method of least square fit to linear equation, Non-linear curve fitting, background correction, mathematical manipulation in data using origin.

Unit IV

Nature and Scope of Ethics, Challenges and Importance of Ethics, Ethics in Research, Ethics and Academic Honesty, Ethics in Writing, Academic Integrity, Research Misconduct/Fabrication/Unethical Practices Academic/Research: Falsification, Manipulation or Tempering of Data Literature. Review and Proper Use of E-Resources, Using Design thinking Methods to Avoid Plagiarism. Writing Quality Academic Publications, Scientific Reading, Cite and Write, Plagiarism Policies, Penalties and Consequences.

Text and Reference Books:

1. Kumar Ranjit, Research Methodology: A Step by Step Guide for Beginners, Sage Publication, 2014.
2. Kothari C.R. : Research Methodology, New Age International, 2011.
3. Thanulingom N : Research Methodology, Himalaya Publishing
4. C. Rajendar Kumar : Research Methodology , APH Publishing.
5. Pradeep K.Sinha, Computer Fundamentals - 8th Edition, BPB Publications
6. Nicola L. C. Talbot, LaTeX for Complete Novices
7. Stefan Kottwitz, LaTeX Beginner’s Guide, Packt Publishing, 2011
8. Muhammad Arsalan, Origin Software: A complete Guide for new users.
9. John G D'Angelo, Ethics in Science, Ethical Misconduct in Scientific Research.
10. Partha Pratim Ray, A Guide to Research and Publication Ethics.
11. Sandra C. Greer, Elements of Ethics for Physical Scientists.

Pre-Ph.D. Course Work Syllabus

Paper - II

EXPERIMENTAL TECHNIQUES IN PHYSICS

Unit – I

Quasielectrons, plasmons, The Dielectric constant of the electron gas, Ion-ion interactions; Phonons; Spin-spin interactions; Magnons; Diamagnetism; Paramagnetism. Theory of NMR, ESR techniques, Superconductivity, BCS Theory, Superfluidity.

Unit – II

Structural and Compositional Characterization, Basics of radiation matter interaction, Basics of electron matter interaction, Basic properties of Fourier Transform, Elastic Scattering, Diffraction of electrons, photons and neutrons. Basics of X – ray diffraction (XRD), grazing incidence and powder XRD, Energy Dispersive X-Ray analysis (EDX). Small Angle X-Ray Scattering (SAXS)**.**
Scanning Probe microscopy: Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Magnetic Force Microscopy (MFM), Scanning Tunnelling Microscopy (STM), Transmission Electron microscopy (TEM): Basic principle, Brief idea of set up–details of components, Different modes and its importance.

Unit – III

Physical basis, theory, instrumentation and applications of X-Ray. Fluorescence Spectroscopy; LASER fluorimetry; Gamma-Gamma method; Neutron activation analysis and Neutron-Neutron method. Gamma Ray Spectrometric Technique. Magnetic Neutron Scattering, Small Angle Neutron Scattering (SANS), Neutron reflectometry for thin film.

Unit – IV

X- Ray Photoelectron Spectroscopy: Basic Components of Raman system, Spectrometer and Detectors, Raman Spectroscopy of Solid and Liquids, Raman spectroscopy of Materials, Instrumentation, Basic Components, IR sources. Spectrometer and Detectors, Infrared absorption spectroscopy. FWHM of the vibrational modes, area etc. Fourier Transform Infrared Spectroscopy (FTIR), UV- Vis. Spectroscopy.

Text and Reference Books:

1. Nadia Crawford, Nuclear Physics: Concepts and Techniques
2. Stefaan Tavernier, Experimental Techniques in Nuclear and Particle Physics.
3. Neil W. Ashcroft, N. David Mermin, Solid State Physics.
4. Charles Kittel, Introduction to Solid State Physics.
5. H. Ibach, Solid State Physics: An Introduction to Theory and Experiment.
6. James D. Patterson, Bernard C. Bailey, Solid-State Physics: Introduction to the Theory.
7. Hendrik Bluhm, Thomas Brckel, Markus Morgenstern, Gero Von Plessen, Advanced Solid State Physics.
8. Thomas C. Weinacht, Brett J. Pearson, Time-Resolved Spectroscopy: An Experimental Perspective.
9. M. I. Pergament, Methods of Experimental Physics
10. F. Reif*:* Fundamentals of Statistical and Thermal Physics.
11. R. Pathria: Statistical Mechanics.
12. Donald H. Perkins*:* Introduction to high energy physics
13. Mandl, Shaw*:* Quantum Field Theory.
14. Demtroeder W, Molecular Physics - Theoretical Principles and Experimental Methods

Pre-Ph.D. Course Work Syllabus
Paper - III
THEORETICAL METHODS IN PHYSICS Research

UNIT – I

Ion beam Technology, Ion beam irradiation and ion implantation in physics research especially in materials science, nuclear physics and plasma physics. Basics of nuclear techniques for ion beam analysis.

UNIT- II

Quantum confinement and surface effect, 2-D, 1-D and 0-D Nano systems, Quantum dots and 1-D nanostructures, Nanocomposites of inorganic and organic systems, Self-assembly hierarchic structures and advanced functional materials for applications in energy harvesting, catalysis, sensors etc.

UNIT III

The electron gas without interaction; Electrons in a periodic potential. The interacting electron gas; Schrodinger Perturbation Theory, Scattering Theory, Partial Wave Analysis, Born Approximation and Its validity. The Hartree-Fock approximation, Computational Techniques: Basics of ab-initio calculations, basic principles of density functional theory (DFT), exchange correlation energy functional, applications of DFT.

UNIT IV

Landau theory for phase transitions. Ising model: transfer matrix method; Onsager solution of 2-dimensional Ising model. Non-equilibrium Statistical Mechanics: Response function and susceptibility; fluctuation-dissipation theorem; irreversibility and the master equation; Fokker Planck and diffusion equations.

Text and Reference Books:

1. Nadia Crawford, Nuclear Physics: Concepts and Techniques
2. Stefaan Tavernier, Experimental Techniques in Nuclear and Particle Physics.
3. Neil W. Ashcroft, N. David Mermin, Solid State Physics.
4. Charles Kittel, Introduction to Solid State Physics.
5. H. Ibach, Solid State Physics: An Introduction to Theory and Experiment.
6. James D. Patterson, Bernard C. Bailey, Solid-State Physics: Introduction to the Theory.
7. Hendrik Bluhm, Thomas Brckel, Markus Morgenstern, Gero Von Plessen, Advanced Solid State Physics.
8. Thomas C. Weinacht, Brett J. Pearson, Time-Resolved Spectroscopy: An Experimental Perspective.
9. M. I. Pergament, Methods of Experimental Physics
10. F. Reif*:* Fundamentals of Statistical and Thermal Physics.
11. R. Pathria: Statistical Mechanics.
12. Donald H. Perkins*:* Introduction to high energy physics
13. Mandl, Shaw*:* Quantum Field Theory.
14. Demtroeder W, Molecular Physics - Theoretical Principles and Experimental Methods