

## Master of Science(M.Sc.) in Physics 2006-2008

### COURSE CURRICULAM

#### Course Structure

Paper code	Paper	Nomenclature	No of Lectures (hrs)	Duration of Exam	Max Marks	External Exam	Internal Marks
<b>M.Sc.(Previous)</b>							
4161	I	Mathematical Physics and Computational Physics	120	3hrs	100	75	25
4162	II	Classical Mechanics, Electrodynamics and Plasma Physics	120	3 hrs	100	75	25
4163	III	Quantum Mechanics	120	3 hrs	100	75	25
4164	IV	Electronics	120	3 hrs	100	75	25
4165	V	Practical: General Physics	150	6 hrs	75	75	Xx
4166	VI	Practical: Electronics	150	6 hrs	75	75	Xx
4167	VII	Project & Viva Vocie	Xxx	Xxx	50	50	xxx
<b>M.Sc.(Final)</b>							
5161	I	Atomic, Molecular and Statistical Physics	120 hrs	3hrs	100	75	25
5162	II	Solid State Physics	120 hrs	3 hrs	100	75	25
5163	III	Nuclear and Particle Physics	120 hrs	3 hrs	100	75	25
<b>Special Paper (Any one of the following papers )</b>							
5164 A	IVA	Condensed Matter Physics	120 hrs	3 hrs	100	75	25
5164 B	IVB	Non-Linear Dynamics and Chaos	120 hrs	3 hrs	100	75	25
5164 C	IVC	Communication Electronics and Atmospheric Science	120 hrs	3 hrs	100	75	25
5164 D	IVD	Informatics and Computer Visualization	120 hrs	3 hrs	100	75	25
5164 E	IVE	Advanced Digital Electronics	120 hrs	3 hrs	100	75	25
5164 F	IVF	X-ray and Nuclear Spectroscopy	120 hrs	3 hrs	100	75	25
5164	IVG	Advanced Solid State	120	3 hrs	100	75	25

G		Physics	hrs				
5164 H	IVH	Quantum Field Theory	120 hrs	3 hrs	100	75	25
5164 I	IVI	Astronomy and Astrophysics	120 hrs	3 hrs	100	75	25
5165	V	Practical: Nuclear Physics	150 hrs	6 hrs	75	75	Xx
Practical : Based on Special Paper opted by the student (One of the following)							
5165 A	VIA	Practical: Based on Special Paper IVA	150 hrs	6 hrs	75	75	Xx
5166 B	VIB	Practical: Based on Special Paper IVB	150 hrs	6 hrs	75	75	Xx
5166 C	VIC	Practical: Based on Special Paper IVC	150 hrs	6 hrs	75	75	Xx
5166 D	VID	Practical: Based on Special Paper IVD	150 hrs	6 hrs	75	75	Xx
5166 E	VIE	Practical: Based on Special Paper IVE	150 hrs	6 hrs	75	75	Xx
5166 F	VIF	Practical: Based on Special Paper IVF	150 hrs	6 hrs	75	75	Xx
5166 G	VIG	Practical: Based on Special Paper IVG	150 hrs	6 hrs	75	75	Xx
5166 H	VIH	Practical: Based on Special Paper IVH	150 hrs	6 hrs	75	75	Xx
5166I	VI I	Practical: Based on Special Paper IVI	150 hrs	6 hrs	75	75	Xx
5167	VII	Project & Viva Voce			50	50	

In order to pass candidates are required to obtain 36% of theory total and 36% of practical total separately. In each paper, minimum of 25% of max. marks of external examination must be obtained. All other rules will be that of Post graduate examinations in Science.

Internal Assessment marks will be awarded by a committee appointed by the Head, Department of Physics consisting Head of the Department, teachers concerned and a senior faculty member. The committee will award internal marks based on the performance of the students in the following:

**Assignments:** 40% of the internal assessment marks for each theory paper will be awarded based on the performance in the assignments regularly given to the students. Minimum of two assignments, each must be of two to three hour's duration (home assignment) from each unit of the course.

**Internal examination conducted by the Department:** 40% of the total internal assessment marks for each theory paper will be awarded on the basis of the performance in the written examination conducted by the faculty, one during November-December and the other during Feb-March period.

**Seminar & Oral examination:** 20% of the total internal assessment marks for each paper will be awarded based on the performance in a seminar and Internal viva examination. A committee consisting local examiners preferably during internal examination will conduct at least one Internal Viva Voice examination per paper.

Candidates who fail to appear in both internal examinations will be awarded zero marks.

**Viva Voce and Project:**

- (a) The External Viva-Voce Examination will be conducted by one of the practical examiners. Each candidate is required to present his project work and viva voce examination will be conducted to test the candidate's understanding in theory, practical & projects.
- (b) Each candidate is required to select a project under a supervising teacher at the beginning of the course. The candidate is required to prepare a detailed project report and submit the same to the external examiner
- (c) In the M.Sc (Previous) class, students are required to select a project topic and conduct literature survey. Students must collect sufficient literature and submit the same during Project examination.
- (d) If a candidate fails to submit the project or fails to attend the external viva or both, he will be awarded zero marks.

## M.Sc (Previous) PHYSICS 2006-2007

### PAPER-I: MATHEMATICAL PHYSICS AND COMPUTATIONAL PHYSICS

#### UNIT – I

##### **Vectors:**

Orthogonal, curvilinear coordinates and expressions of gradient, divergence and curl in them. Gauss's, Stoke's and Green's theorems. Applications to hydrodynamics, heat flow in solids, gravitational potential. Maxwell's equation and wave equation.

##### **Tensors:**

Coordinate transformations, scalars, contravariant vectors, and covariant vectors. Addition, multiplication and contraction of tensors. Associated tensors, differentiation of tensors. Intrinsic and covariant derivatives of tensors. Tensors of higher order, applications to dynamics of a particle.

##### **Matrices:**

Special matrices including orthogonal hermitian and unitary matrices. Number of independent parameters of special matrices. Inverse, linear transformation of matrices, partitioning and rank. Linear equations (simple cases), Eigen values and Eigen vectors, diagonalization.

#### UNIT –II

##### **Second Order Differential Equations:**

Partial differential equations of theoretical physics, separation of variables, singular points, series solutions – Frobenius method, Wronskian, Non-homogeneous equations, Greens function. Orthogonal functions, self-adjoint differential equations, boundary conditions, Hermitian operators, Schmidt Orthogonalization, orthogonal polynomials, completeness of eigenfunctions.

##### **Fourier and Laplace Transforms:**

Differentiation and integration of Fourier series, orthogonal functions, Fourier transforms, Analysis of the vibrations of a string. Laplace transforms, inverse transform, partial fraction expansion, Laplace transform derivatives, and substitution properties of Laplace transform, application to damped oscillator. RLC analog. Convolution or Faltung theorem.

#### UNIT – III

##### **Special Functions:**

Bessel functions of the first kind, orthogonality, Neuman function Hankel function. Asymptotic expansions. Spherical Bessel functions. Legendre functions-generating function, recurrence relations, properties, orthogonality, Rodrigues formula, Associative Legendre functions, spherical harmonics, Hermite functions. Laguerre functions.

#### UNIT –IV

##### **Complex Variables:**

Functions of complex variable, Cauchy Riemann conditions, Cauchy Integral theorem, Cauchy integral formula, Laurent expansion. Analytical functions and conformal mapping. Schwartz-Christoffel transformation.

Calculus of residues – Singularities, residue theorem, Jordan's lemma, singularities on contours of integration, evaluation of definite integrals.

Analytical continuation, Stirlings formula

##### **Group Theory:**

Elementary properties and definition, representation of groups, orthogonality relation for irreducible representation, reduction of representations, cyclic group, unitary group, three dimensional rotation group, two dimensional rotation group, permutation group.

#### UNIT – V

(Note: Students are required to use computers to write and test computer program developed for the numerical methods using FORTRAN 98 in the practical Lab.

**Numerical Methods** Iterative methods to find roots-Newton Raphson, bisection, Gauss-Seidel method for solution of simultaneous equations, Matrix inversion, Eigen values and Eigen vectors of matrices, Integration by Simpson, Quadrature method, differentiation by Runge-Kutta method. Least squares method-linear and polynomial regression. Montecarlo evaluation of Integrals

##### **Recommended Books:**

Mathematical methods for Physicists – G. Arfken

Applied Mathematics for Physicists and Engineers – L. A. Pipes

Matrices and Tensors in Physics – A.W. Joshi

Computer Oriented Numerical methods – V. Rajaman

FORTRAN Programming: V. Rajaraman

Numerical Mathematical methods – Dafilovich  
Advanced Engineering Mathematics – E.Kreyszig  
Methods of Mathematical Physics – Dettman

## **PAPER II: CLASSICAL MECHANICS, ELECTRODYNAMICS AND PLASMA PHYSICS**

### **UNIT – I**

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

Lagrange's equations; gyroscopic forces; dissipative systems; Jacobi integral; gauge invariance; generalized coordinates and momenta; integrals of motion; symmetries of space and time with conservation laws; invariance under Galilean transformations.

Rotating frames; inertial forces, terrestrial and astronomical applications of Coriolis force.

### **UNIT – II**

Central force; definition and characteristics; Two-body problem, closure and stability of circular orbits, general analysis of orbits, artificial satellites, Rutherford scattering.

Principle of least action; derivation of equations of motion; variation and end points. Hamilton's canonical equations. Hamilton's principle and characteristic functions, Hamilton-Jacobi equation.

Canonical transformation: generating functions, properties: group property; examples: infinitesimal generators, Poisson bracket, Poisson theorems, angular momentum PBs. Small oscillations: normal modes and coordinates.

### **UNIT – III**

Review of four – vector and Lorentz transformation in four-dimensional space. Electromagnetic Field tensor in four dimensions and Maxwell's equations. Dual field tensor, wave equation for vector and scalar potential and solution.

### **UNIT – IV**

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, reaction force of radiation.

### **UNIT – V**

Motion of charged particles in electromagnetic field: nonuniform fields, diffusion across magnetic fields, time varying **E** and **B** fields, Adiabatic invariants: First, second and third adiabatic invariants.

Elementary concepts: Derivation of moment equations from Boltzmann equation, Plasma oscillations, Debye shielding, Plasma parameters, Magnetoplasma, Plasma confinement.

Hydrodynamical description of plasma: Fundamental equations, hydromagnetic waves, magnetosonic and Alfvén waves.

#### **Text and Reference Books:**

1. Classical Mechanics, N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991)
2. Classical Mechanics, H. Goldstein (Addison Wesley, 1980)
3. Mechanics, A.Sommerfeld (Academic Press, 1952)

4. Introduction to dynamics, I. Percival and D. Richards (Cambridge Univ. Press, 1982)
5. Panofsky and Phillips: Classical Electricity and Magnetism
6. Chen: Plasma Physics
7. Bittencourt: Plasma Physics
8. Jackson: Classical Electrodynamics

## Paper –III, Quantum Mechanics

### UNIT – I

**Towards Quantum Mechanics:** Inadequacy of classical mechanics; Black body radiation and Planck' hypothesis, The photoelectric effect, Compton effect, The Frank-Hertz experiment, Hamilton's principle.

**Schrödinger equation:** The Schrödinger equation, Normalisation, and probability interpretation of  $\psi$ , Equation of continuity, Expectation values, Ehrenfest theorem, Admissible wave functions.

**General Formalism of wave mechanics:** Vectors; examples of linear vector spaces, norm of a vector, orthonormality and linear independence, Basis and dimensions, Completeness (Closure property), Hilbert space, subspaces. Operators; Equality, product, sum, power, function, inverse of operators, eigenvalues and eigenvectors of an operator. Positive definite and continuous and bounded operators, Hermitian operators, Unitary operators, Projection operators, Completeness of eigenfunctions, Bra and Ket notation for vectors, Dirac Delta function, Representation theory, Matrix elements of change of basis, Unitary transformation. Coordinate and momentum representation.

**Uncertainty and the Commutation relations:** Uncertainty relation of  $\mathbf{x}$  and  $\mathbf{p}$ , states with minimum uncertainty product, Commutators, simultaneous eigenfunctions.

### UNIT – II

**One dimensional problems (stationary states):** A particle in a square well potential and square potential barrier, Simple harmonic oscillator by Schrödinger

equation and by operator method, properties of harmonic oscillator wavefunctions and creation and annihilation operators.

**The equations of motion:** Schrodinger picture, Heisenberg picture, Solution of Schrodinger equation for spherically symmetric potential; spherical harmonics, Hydrogen atom.

**Theory of Angular momentum:** The definition, angular momentum of a system of particles, Matrix representation, Pauli spin matrices, the spin eigen vector, orbital angular momentum, addition theorem, addition of angular momenta; Clebsch-Gordan coefficients, the selection rules, properties of CG coefficients (without proof): symmetry, orthogonality, and recursion relations.

#### UNIT – III

**Theory of scattering:** The scattering experiment, relationship of the scattering cross-section to the wave function, the scattering amplitude, method of partial waves, expansion of a plane wave in terms of partial waves, scattering by a central potential  $V$ , zero energy scattering, the scattering length, scattering by a square well potential, effective range, resonance scattering (No derivation). The Born approximation, the integral equation for scattering, Criterion for the validity of the Born approximation, scattering of electrons by atoms.

**Identical particles:** The identity of particles, the indistinguishability principle, symmetry of wave functions, spin and statistics, the Pauli Exclusion Principle, illustrative example: the Helium atom, scattering of identical particles, case of spin half and spin zero particles.

#### UNIT – IV

**Approximation methods:** Approximation methods for time independent problems, The WKB approximation; Principle of the method, The WKB wave function, Criterion for the validity of the approximation, Connection formulae, Applications to one dimensional bound system, Penetration of a potential barrier. The Variational method; bound state (Ritz method), Applications to linear harmonic oscillator, Helium atom.

**Time independent perturbation theory:** Non-degenerate case; applications to Anharmonic oscillator ( $x^4$ ) and linear harmonic oscillator, degenerate case; applications to linear Stark effect and the Zeeman effect in the Hydrogen atom.

#### UNIT –V

**Methods for time dependent problems:** Time dependent perturbation theory, constant perturbation, Transition to continuum, Fermi's golden rule, scattering cross section in the Born approximation, Harmonic perturbation, radiative transitions in atoms, dipole transitions, selection rules.

**Relativistic wave equations:** Introduction, The Klein-Gordan equation, the first order wave equations, The Dirac equation, Properties of Dirac matrices, the free

Dirac particles, equation of continuity, non-relativistic limit, spin-orbit coupling, Hole theory.

**Text and reference books:**

1. Quantum Mechanics, V.K. Thankappan, (New Age International).
2. A textbook of Quantum Mechanics, P.M. Mathews and K. Venkatesan. (Tata McGraw-Hill).
3. Quantum Mechanics, J.L. Powell and B. Crasemann, (Addison-Wisley).
4. Quantum Mechanics, L.I. Schiff (McGraw-Hill).

**PAPER – IV :ELECTRONICS**

Note:

M.K.S.A system of units is to be used. At least 50% of the question from will be problem based on theory covered in each unit. Problems will be of the level of that given in Appendix C of the text book “Integrated Electronics” by Millman & Halkias.

**UNIT – I**

**Low Frequency Amplifiers:**

Transistor Hybrid – model, h-parameters, Analysis of transistor amplifier circuit using h parameters, Emitter follower, comparison of amplifier configuration, cascading amplifiers, simplified model of common emitter, common collector configuration, CE amplifier with emitter resistance, high input impedance transistor circuit (Darlington Pair)

**High Frequency and Multistage Amplifiers:**

Hybrid -  $\pi$  common emitter transistor model, hybrid- Pi conductance and capacitance, validity and variation of hybrid – PI model, short circuit current gain, current gain with resistive load, single stage CE amplifier response, gain band width product, emitter follower at high frequencies. Classification of amplifiers, distortion in amplifiers, Noise, frequency response, Bode plots, step response, bandwidth pass of cascade stages, Multistage CE amplifier.

**UNIT – II**

### **Feed back amplifiers and oscillators:**

General characteristics of negative feed back amplifier, input and output resistances, method of analysis, voltage series, current series, voltage shunt feed back, voltage series feed back pair, effect of feedback on amplifier band width, double and three pole transfer function with feed back. Stability – Nyquist criterion, gain and phase margin, compensation by modification of beta network, sinusoidal oscillators, resonant circuit oscillator, general theory of oscillator, crystal oscillator.

### **UNIT – III**

**Linear integrated circuits:** Operational amplifier, differential amplifier, emitter coupled differential amplifier, transfer characteristics, offset voltage, frequency response, dominant pole compensation, pole-zero compensation, basic applications, differential DC amplifier, analog integration and differentiation, analog computation, active filters, non-linear analog system – comparator, sample and hold circuits, logarithmic amplifier, wave form generators, Schmitt trigger.

### **UNIT –IV**

#### **Power circuits and Systems:**

Class A large-signal amplifiers, second harmonic distortion, Higher order harmonic generations, the transformer coupled audio amplifiers, efficiency, push-pull amplifiers, Class B amplifiers, Class AB operations, Regulated power supplies, design of Series voltage regulated power supplies, monolithic regulators, the four layer diode, p-n-p-n characteristics, Bilateral Diode switch, the silicon controlled rectifiers, Gate ON and OFF times, characteristic of SCR, SCS, the triac or Bilateral triode switch, power control – SCR control, Full-wave rectified operation control circuit, AC control, Construction, Characteristics and simple applications of UJT, photodiodes, solar cells and LCD.

### **UNIT – V**

#### **Digital system building blocks:**

NAND and NOR gates as universal gates, standard gate assemblies, K-maps and simplification of Boolean functions, Arithmetic circuit: adders, subtractor, comparators, decoders, Multiplexers, encoder and demultiplexers, ROM and application, sequential digital systems: SR Latch, flip-flops: Flip-Flop as a basic memory element, RS and JK flip-flops, Triggering of flip-flops, master slave JK flip-flop, shift registers, Counters: Asynchronous and synchronous binary and BCD counters. A/D and D/A conversions: Basic principles and simple applications.

### RECOMMENDED BOOK:

1. Integrated Electronics by Millman and Halkias ( McGraw Hill).
2. Digital Logic and computer Design: M. M. Mano ( Prentice Hall of India).
3. Electronic Devices and Circuit theory by R. Boylestead and L. Nashelsky, (Prentice Hall of India).
4. Electronic fundamentals and applications by John D. Ryder (Prentice Hall of India).
5. Electronic Devices and Circuits by Y.N. Bapat ( Tata MacGraw Hill Publisher Limited).
6. OP-Amp and Linear Integrated Circuits by Ramakant A. Gayakwad (Prentice Hall of India).

### **Paper V : Practical-I: General Physics**

**Max. Marks : 75**

### **NOTE:**

1. Students are required to complete at least ten experiments
2. Error analysis and estimation will be an integral part of all experiments.
- 3 Students are required to go through workshop practice.

Students are required to give at least one seminar on experiments allotted to them by the teacher.

Marking scheme: Section-A: 60 Marks, Section-B: 15 Marks

### **LIST OF EXPERIMENTS**

1. Measurement of arc spectra by constant deviation spectrometer.
2. Determination of elastic constants of glass by method of Cornu's fringes.
3. Determination of coefficient of thermal conductivity of metal by Angstrom's method.

4. Study of Hall effect: Determination of Hall coefficient of given semiconductor: Identification of type of semiconductor and estimation of charge carrier concentration.
5. Determination of  $\lambda$ ,  $d\lambda$ , and thickness using Michelson's interferometer.
6. Determination of wavelength of light emitted by He-Ne laser and to verify the law governing Interference from a Young's double slit experiment.
7. (a) Measurement of wavelength of He-Ne laser light using ruler. (b) Measurements of thickness of thin wire with laser.
8. Study of Faraday effects using He-Ne laser.
9. Investigation of Faraday's effect and to determine Verdt's constant.
10. To plot the polar curve of a filament lamp and to determine its mean spherical intensity.
11. To study the dissociation limit of Iodine.
12. Study of Zeeman effect : Determination of  $e/m$  of electron by normal Zeeman effects using Fabry Perot Etalon.
13. To investigate creep in metals.
14. To analyze principal stresses in a loaded Araldite specimen using the photo elastic technique.
15. Young's modulus of a metal beam using strain gauge.
16. Thermal conductivity of a liquid using radial heat flow.
17. To calibrate a Chromel-Alumel thermocouple by means of a cooling method (Differential Thermal Analysis).
18. To investigate the variation of capacitance and power factor with temperature change in ferroelectrics.
19. To study phase transition in Monel metal.
20. Hysteresis in Gadolinium Iron Garnet using an optical microscope.
21. Susceptibility measurement of paramagnetic anisotropic crystal.
22. To verify Gaede's equation.
23. B-H curve of the specimen in the form of Rowland ring.
24. Hysteresis in a ferroelectric sample.
25. Jamin's interferometer's method for  $n_{\text{air}}$  (refractive index of air using He-Ne Laser).
26. Measurements of resistivity of semiconductor by four-probe method at different temperatures and determination of band gap.

27. Quinke's method for the susceptibility of a liquid.
28. Beam characteristics of a He-Ne laser beam.
29. Refractive index of film emulsion using diffracto-interference profile.
30. Verification of Fresnel's laws of reflection and refraction.
31. Cornu's method for the Poisson's ration ( $\mu$ ) using the He-Ne laser.
32. Determination of Ionization of potential of Lithium.
33. Determination of dissociation Energy of Iodine (I) Molecule by photography the absorption bands of I in the visible region.
34. To study the fluorescence spectrum of DCM dye and to determine the quantum yields of fluorescence maxima and full width at half maxima for this dye using monochromator.

### **Section-B**

#### **Workshop Practice**

Students are required to undergo workshop practice for a period of  
4 hrs/Week

1. Getting acquainted with a mechanical Workshop
2. Machine Drawing
3. Operation of Lathe, Drilling, cutting machines etc. for mechanical fabrication work
4. Glass Blowing methods

#### **PAPER VI : PRACTICAL-II: ELECTRONICS & COMPUTATIONAL METHODS**

1. Students are required to complete at least 12 experiments
3. During the examination, the students are required to submit the experiments designed and fabricated by them
3. Students are required to give at least one seminar on experiments allotted to them by the teacher.

Marking scheme: Section-A: 60 Marks, Section-B: 15 Marks

### LIST OF EXPERIMENTS

(All experiments are to be designed and fabricated by the students)

1. Measurement of operational amplifier parameters.
2. Study of difference and Logarithmic amplifier.
3. Study of active filter circuits
4. Study of active integrator and differentiator circuits
5. Study of wave form generators: (a) Square wave generator (astable multivibrator), (b) Pulse generator (monostable multivibrator) and triangular wave generator.
6. Study of Oscillators using op-amp
7. Study of Schmitt trigger circuit
8. Design of a two stage common emitter Transistor amplifier and study of bias stability.
9. Study of the dependence of feedback ratio on gain, bandwidth, impedance of a voltage series/shunt and current series/shunt feedback amplifier
10. FET and MOSFET characterization and application as an amplifier.
11. Study of FET as VVR and AGC devices
  
12. Digital I : Basic logic Gates, TTL, NAND and NOR
  
13. Study of RS, JK, Master-Slave flip flops and shift register
14. Study of four bit adder, decoder, multiplexer and demultiplexer
15. (a) Study of characteristics and applications of silicon controlled rectifier  
(b) Study of characteristics and applications of Uni-Junction Transistor  
I Relaxation oscillator and triggering of SCR circuits
  
16. Study of Push – Pull amplifiers

17. Design of a Regulated power supply: (a) Study of series voltage regulated power supply and (b) study of IC regulated power supply
18. Frequency, voltage and temperature measurements.
19. Introduction to SPICE: Spice the gate way to electronic circuit simulations.
20. Simulation and study of electronics problems.

### **Section-B**

#### **COMPUTATIONAL LAB**

##### **Minimum 4 hrs/week**

Students are required to use computers to write and test computer program developed for the numerical methods Unit IV of Paper-I using FORTRAN 98 in the practical Lab.

## **M.Sc. (Final), PHYSICS: 2007-2008**

### **Paper-I: Atomic and Molecular Physics and Statistical mechanics**

#### **UNIT-I**

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 and non-equivalent electrons, Normal and anomalous Zeeman effect. Paschen Back effect, Stark effect, two electron systems, Interaction energy in LS and JJ coupling, Hyperfine structure (qualitative).Line broadening mechanisms.

#### **UNIT-II**

Types of molecules, Diatomic linear Symmetrical top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotor, Energy levels and spectra of non rigid rotor, Intensity of rotational lines, Stark modulated microwave spectrometer(qualitative)

#### **UNIT-III**

Vibrational energy of diatomic molecule, Diatomic molecule as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrational rotator, vibrational spectrum of diatomic molecule,PQR branches IR spectrometer (Qualitative)

#### **UNIT-IV**

Foundations of statistical mechanics: Specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibbs paradox Micro canonical ensemble, phase space, trajectories and density of states, Liouville's theorem, canonical and grand canonical ensembles,

partition function, calculation of statistical quantities, Energy and density fluctuations.

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

#### **UNIT-V**

Cluster expansion for a classical gas, virial equation of state, Ising model; mean field theories of the Ising model in three, two and one dimensions. Exact solutions in one dimension. Landau theory of phase transition, Critical Indices, scale transformation and dimensional analysis. Correlation of space –time dependent fluctuations, fluctuations and transport phenomena, Brownian motion, Langevin theory, fluctuation dissipation theorem, The Fokker-Planck equation.

#### **Reference Books**

Introduction to Atomic Spectra- H.E. White (T)

Fundamentals of Molecular Spectroscopy-CB Banwell (T)

Spectroscopy Vol, I,II,III-Walker & Straughen

Introduction to Molecular Spectroscopy: G M Barrow

Spectra of diatomic Molecules: Herzberg

Molecular Spectroscopy- Jeanne L Mc Hale

Molecular Spectroscopy-J M Brown

Spectra of Atoms and Molecules-P F Bemath

Modern Spectroscopy: J M Holias

Statistical and Thermal Physics F Reif

Statistical Mechanics K Huang

Statistical Mechanics R K Panthria

Statistical Mechanics R Kubo

Statistical Mechanics Landau and Lifshitz

## Paper-II: Solid State Physics

### UNIT-I

#### **Crystal Structure:**

Crystal classes and systems, periodic array of atoms, fundamental types of lattices, 2d and 3d lattices, Index system for crystal planes, simple crystal structures, direct imaging of atomic structure, nonideal crystal structures, elementary ideas of point defects: line defects, planar faults, surface and volume defects, lattice vacancies, interstitials, colour centers, F-centers and dislocations.

#### **Reciprocal lattice:**

Reciprocal lattice, diffraction of waves by crystals, X-ray and neutron diffraction, scattered wave amplitude, structure factor, Brillouin Zones, Fourier analysis of the basis, quasi crystals.

### UNIT-II

#### **Phonons I: Crystal Vibrations:**

Lattice vibrations, phonons, vibrations of crystals with monoatomic basis, two atoms per primitive basis, quantization of elastic waves, phonon momentum, Inelastic scattering by phonons.

#### **Phonons II: Thermal Properties:**

Specific heat of solids, phonon Heat Capacity, Anharmonic crystal interactions, Thermal Conductivity

### UNIT-III

#### **Free Electron Fermi Gas:**

Free electron theory- Fermi statistics, Energy levels in one dimension, effect of temperature on the Fermi-Direct Distribution, Free electron gas in three dimensions, Heat Capacity of the Electron gas, Electrical Conductivity and Ohm's Law, Motion in magnetic fields, Thermal conductivity of metals, Nano structures

#### **Energy Bands:**

Nearly Free Electron model, Bloch functions, Kroning-Penney model, wave equation of electron in a periodic potential, Number of orbitals in a band, energy bands in metals, insulators and semiconductors, tight binding approximations.

**Fermi Surfaces and Metals:**

Reduced Zone Scheme, periodic Zone scheme, construction of Fermi surfaces, Electron orbits, hole orbits, open orbits, Experimental methods in Fermi surface studies.

**UNIT-IV****Superconductivity:**

Experimental Survey, Theoretical survey, High Temperature Superconductors.

**Diamagnetism and Paramagnetism:**

Langevin Diamagnetism equation, quantum theory of diamagnetism of mononuclear systems, Paramagnetism, quantum theory of paramagnetism, Hund's rules, cooling by isotropic demagnetization, paramagnetic susceptibility of conduction electrons

**UNIT-V****Ferromagnetism and Antiferromagnetism**

Ferromagnetic order, magnons, Neutron magnetic scattering, ferromagnetic order, ferromagnetic order, Antiferromagnetic order, Ferromagnetic domains, single domain particle, magnetic bubble domains

**Magnetic resonance:**

Nuclear magnetic resonance, Line width, hyperfine splitting, nuclear quadrupole resonance, ferromagnetic resonance, Antiferromagnetic resonance, Electron paramagnetic resonance, Principle of maser action.

**Recommended Book:**

1. Introduction to Solid State Physics by Charles Kittel Seventh Edition
2. Solid State Physics by A.J. Dekker

## **Paper-III : NUCLEAR and PARTICLE PHYSICS**

### **UNIT – I**

Nucleon – nucleon interaction: Exchange forces and tensor forces. Meson theory of nuclear forces. Nucleon – nucleon scattering: Effective range theory. Spin dependence of nuclear forces. Charge independence and charge symmetry of nuclear forces. Isospin formalism. Yukawa interaction. P-p scattering and its comparison with the results of n-p scattering, properties of deuteron (radius, magnetic moment and spin), theory of ground state of deuteron (assuming central potential).

Magnetic moment of nuclei (Schmidt model of measuring the spin and magnetic moment of nuclei). Quadrupole moment of the nucleus. Electric multipole moments of nucleus. Excited state of nuclei (spin and parity of excited nucleus).

### **UNIT – II**

Direct and compound nuclear reaction mechanisms (Q values). Cross sections in terms of partial wave amplitudes. Compound nucleus. Scattering matrix. Reciprocity theorem. Breit-Wigner one level formula. Resonance scattering.

Liquid drop model. Bohr-Wheeler theory of fission. Experimental evidence for shell effects. Shell model. Spin-orbit coupling. Magic numbers. Angular momenta and parities of nuclear ground states. Qualitative discussion and estimates of transition rates. Collective model of Bohr and Mottelson.

Beta decay: Fermi theory of beta decay. Shape of the beta spectrum. Fermi-Kurie plot and its application. Total decay rate. Angular momentum and parity selection rules.

Comparative half lives. Allowed and forbidden transitions. Selection rules. Parity violation. CPT theorems.

Gamma decay: Multipole transitions in nuclei. Angular momentum and parity selection rules. Internal conversion. Nuclear isomerism.

### **UNIT – III**

Interaction of charged particle with matter. Classical theory for calculating  $dE/dX$  for heavy, non-relativistic, charged particle. Causes for difference between the energy loss by heavy charged particles and electrons, relative energy loss by ionization and radiation by electron (no derivation). Difference between the absorption curves of electrons and heavy charged particles. Straggling of particles and protons (less than the binding energy of electrons).

Interaction of gamma ray with matter (photo electric effect, Compton effect and pair production) through varying cross section and atomic number (no derivation).

### **UNIT – IV**

Working and construction of Ionization chamber, Proportional counter, Geiger-Muller counter (dead time of G.M. counter and its determination by two source method). Scintillation counter (inorganic, organic: Production of pulse at anode of phototube, energy resolution, discussion of a typical NaI(Tl) energy spectrum), Solid state detectors (diffused junction and surface barrier detector,. Resolution and discussion of a typical Ge(Li), Si(Li) energy spectrum).

## UNIT – V

Types of interaction between elementary particles. Hadrons and leptons. Symmetry and conservation laws. Elementary ideas of CP and CPT invariance. Classification of hadrons. Strong and weak interaction symmetries: uses of symmetry. Space time and internal symmetries. Lie group's generators and Lie algebra. Casimir operators. SU(2) irreducible representation. Weight diagram. Diagonal generators SU (3) generators. U and V spin. Raising and lowering operators. Root diagram. Weight diagram. Multiplets of SU (n). Baryons and meson multiplets. Symmetry breaking. Quark model. Gell-Mann-Okubo mass formula for octet and decuplet hadrons. Charm, bottom and top quarks.

Perturbative QCD:

1. Colour gauge invariance and QCD Lagrangian. Deep inelastic scattering. The GLAP equations, and alternative approach to the GLAP equations. Common parametrizations of the distribution functions. Structure functions. The spin-dependent structure functions and the MIT bag model.
2. The Drell-Yan process. Small-x physics and the Gribov-Levin-Ryskin equation.

Non Perturbative QCD:

QCD sum rules. The ground state of QCD. Equation of state of a quark. Gluon plasma. Hadronization phase transition.

**Text and Reference Books:**

1. Fundamentals of Nuclear Physics, Varma, Bhandari and Somayajulu, CBS, New Delhi 2005
2. A. Bohr and B.R. Mottelson, Nuclear Structure, Vol. 1 (1969) and Vol. 2, Benjamin, Reading, A, 1975.
3. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988.
4. Ghoshal, Atomic and Nuclear Physics, Vol. 2.
5. H.A. Enge, Introduction to Nuclear Physics, Addison-Wesley, 1975
6. M.K. Pal, Theory of Nuclear Structure, Affiliated East-West, Madras, 1982.
7. Y.R. Waghmare, Introductory Nuclear Physics, Oxford – IBH , Bombay, 1981.
8. R.D. Evans, Atomic Nucleus, McGraw Hill, New York, 1955.
9. I. Kaplan, Nuclear Physics, 2<sup>nd</sup> Ed., Narosa, Madras, 1989.
10. Jagdish Varma, Nuclear Physics Experiments, New Age International 2001
11. B.L. Cohen, Concepts of Nuclear Physics, TMGH, Bombay, 1971.
12. R.R. Roy and B.P. Nigam, Nuclear Physics, Wiley-Eastern Ltd., 1983.
13. I.S. Huges, Elementary particle Physics, Penguin.
14. M. Leon, an introduction to particle physics, Academic Press, New York, 1973.
15. W. Greiner and A Schafer, Quantum Chromodynamics, Springer, Berlin, 1993.
16. F.J. Yndurain, Quantum Chromodynamics: An introduction to the theory of quarks and gluons, Sringer-Verlag, New York, 1983

## **Paper –IV A: Condensed Matter Physics**

### **UNIT-I**

#### **Crystal Physics and X-ray Crystallography:**

External symmetry elements of crystals, sets and groups, symmetry of crystal, symmetry invariance and conservation laws, the crystallographic restriction on symmetry axes, rotation, reflection, inversion and translation, concept of point groups, influence of symmetry on physical properties. Electrical conductivity, Space groups, Bravais lattices, Crystallographic directions and planes, seven crystal systems

Basic theory of X-ray diffraction method, principle of powder diffraction method, interpolation of powder photographs, Indexing of Debye Scherer patterns from powder samples. Determination of lattice parameters using least squares refinement techniques, Oscillation, Laue and rotation crystal methods, indexing of patterns using reciprocal lattice method, Determination of relative structure amplitudes from measured intensities (Lorentz and Polarization factors, Fourier representation of electron density).

### **UNIT-II**

Energy band structure calculation: Nearly free electron model, tight binding method, Cellular methods, Orthogonalization plane wave methods, Green function method

Electrons in solids and Surface States: Interacting electron gas: Hartree-Fock approximations, correlation energy, Screening, Plasma oscillations, Dielectric function of an electron gas in random phase approximation. Limiting cases and Friedel oscillation, strongly interacting Fermi system, Elementary introduction to Landau's quasi particle theory of a Fermi liquid.

### **UNIT-III**

Superconductivity: Manifestation of energy gap, Cooper pairs due to phonons, Type I and II superconductors, BCS theory of superconductivity, Ginzburg-Landau theory and application to Josephson Effect, dc and ac Josephson Effect, macroscopic quantum interference. High temperature superconductivity, general features of high T<sub>c</sub> superconductors. Organic superconductivity (general features and comparison with High T<sub>c</sub> Superconductivity)

Films and Surfaces: Techniques of thin film preparation and thickness measurements, Electrical conductivity of thin films, differences of behavior of thin film from bulk, Boltzman transport equation for a thin film (for diffused scattering)

### **UNIT-IV**

Phase diagrams and Crystal Growth: Phase diagrams, chemical potential for different phase composition, limitation of phase rules, solid solutions, Hume Rothary rule, cooling curves. Thermodynamic potentials and fundamental equations, Nucleation, kinds of nucleation, classical theory of nucleation, Gibbs Thomson equation, Kinetic theory of nucleation, Becker and Doring concept of nucleation rate, Energy of formation of a nucleus, nucleation from melt, Statistical theory of nucleation, nucleation rate. Crystal growth: Classification of methods of crystal growth, principles and methodology, crystal growth from solution, flux growth, crystal growth in gels, melt growth and vapor growth

Advanced materials: Elementary ideas about classification and characterization and preparation techniques of advanced materials: Metals, ceramics, polymers, composites, alloys, Ferro fluids, nanomaterials, semiconductors, biomaterials, low dimensional materials, liquid crystals, quasi crystals, hydrogen storage materials and glasses.

### **UNIT-V**

Magnetic materials: Classification of magnetic ordering, Weiss molecular field theory of ferromagnetism, Domain theory, ferromagnetic domains and concept of Bloch wall, Bloch Wall energy, Heisenberg model, quantum mechanical exchange interactions in magnetism, spin waves and magnons, Kondo effect, Spin glass, RKKY Interactions. Introduction to hard and soft magnetic materials, elementary idea of ferrites, application of ferrites in electronic and magnetic bubbles, Brief introduction to permanent magnetic materials, Brief introduction to disordered magnetic materials and amorphous materials

Neutron Diffraction and Mossbauer effect: Scattering of neutrons from single nuclei, Neutron nucleus scattering from periodic lattice, magnetic scattering of neutron from crystal, scattering lengths and structure factors. Determination of crystal structures and magnetic structures. Brief introduction to Mossbauer effect, Conditions for observing Mossbauer Effect. Mossbauer parameters: Isomer shift, Quadrupole splitting and Magnetic splitting. Experimental method of study of Mossbauer effect, Application of Mossbauer effect in condensed matter physics.

### **Text and Reference Books**

1. Azaroff: X-ray Crystallography
2. Weertman and Weertman: Elementary Dislocation Theory
3. Verma and Srivastava: Crystallography for Solid State Physics
4. C.Kittel: Solid State Physics
5. Azaroff and Beurger: The Powder Method
6. Buerger: Crystal Structure Analysis
7. M. Ali Omar: Elementary Solid State Physics
8. The Physics of Quasicrystals, Eds. Steinhardt and Ostulond
9. Handbook of Nanostructured Materials and Nanotechnology (Vol. 1 to 4), Ed. Hari Singh Nalwa
10. Thomas: Transmission Electron Microscopy
11. Tolansky: Multiple Beam Interferometry
12. Heavens: Thin Films
13. Chopra: Physics of Thin Films
14. Ashcroft and Mermin: Solid State Physics

15. Chaikin and Lubensky: Principles of Condensed Matter Physics
16. Madelung: Introduction to Solid State Theory
17. Callaway: Quantum Theory of Solid State
18. Huang: Theoretical Solid State Physics
19. Kittel: Quantum Theory of Solids

## **Paper IV B: Nonlinear Dynamics and Chaos**

### **UNIT I**

Chaotic dynamics, Classical linear and non-linear vibration theory, maps and flows- A mathematical model of biological population growth (Logistic map) and model of convecting fluids (Lorenz model), Determinism unpredictability and divergence of trajectories (Butterfly effect). Identification of chaotic vibration, non-linear system elements, random inputs, time history, phase plane, Fourier spectrum and autocorrelation, Poincare maps and return maps. Bifurcations- route to chaos, quasi-periodicity and mode locking, transient chaos, conservative chaos, Lyapunov exponents and fractal dimensions, strange non-chaotic motions.

### **UNIT II**

Geometry of mappings and classification of map dynamics, quasi-periodic and stochastic motion, Impact oscillator maps, Fractal orbits. Local stability of 2D maps, Global dynamics of 2-D maps – linear transformation, folding in 2D maps, composition of maps. Saddle manifolds, tangles and chaos, from 2D to 1D maps- kicked rotor, Circle map, Henon map. Period-doubling route to chaos – qualitative features, Poincare maps, bifurcation diagrams, quantitative measures, Feigenbaum numbers, amplitude and subharmonic spectra scaling. Measure of chaos- Lyapunov exponents, probability density functions (PDF) and numerical calculation of PDF, PDF and Lyapunov exponents. 3D flows and maps- Lorentz

model for fluid convection, Duffing equation and “Japanese attractor”, a map from a 4D conservative flow.

### UNIT III

Empirical criteria for chaos in different types of forced oscillations, Theoretical predictive criteria-period doubling criterion, homoclinic orbits and horseshoe maps, Shil'nikov Chaos, intermittent and transient chaos, Chirikov's criterion for conservative chaos and criterion for multiple potential well. Lyapunov exponents-numerical calculation of largest Lyapunov exponent, Lyapunov spectrum, Lyapunov exponent for continuous systems and hyper chaos.

### UNIT IV

Examples of fractals-Koch curve, Cantor set, Devil's staircase and fractal dimensions. Measure of fractal dimensions-point wise dimension, correlation dimension, information dimension and Lyapunov dimension. Fractal generating maps- iterated linear maps and maps on complex plane. Fractal dimension of strange attractors. Multifractals-fractals within fractals and experimental multifractals, optical measurement of fractal dimensions and application of fractals in physical sciences.

### UNIT V

Hamilton's equation and Hamiltonian, phase space, constants of motion and integrable Hamiltonians, non-integrable systems, KAM theorem and period doubling, Henon-Heiles Hamiltonian, area preserving maps - Chirikov standard map and Arnold cat map, dissipative standard map, application of Hamiltonian dynamics.

#### **Text and Reference Books:**

1. Chaotic and fractal dynamics - F. C. Moon (John Wiley and Sons, 1992).

2. Chaos and non-linear dynamics – R. C. Hilborn (Oxford University Press, 2000).
3. Chaos-An introduction to dynamical systems – K. Alligwood, T. Sauer and J. A. Yorke (Springer Verlag, New York, 1997).
4. Chaos in dynamical systems – E. Ott (Cambridge University Press).
5. Chaos in classical and quantum mechanics – M. C. Gutzwiller (Springer Verlag, New York, 1990).

## **PAPER - IV C: COMMUNICATION ELECTRONICS AND ATMOSPHERIC SCIENCE**

### UNIT - I

#### **Antenna:**

Radiation from an antenna, Radiation Resistance of antenna, polar diagram of resonant and non resonant antenna, polar diagram of resonant and non-resonant antenna( Quarter wave vertical) and half wave dipole ,effect of ground on polar pattern, antennae gain, efficiency ,effective length , radiation resistance, beam width, aperture area.

#### Directional Characteristics of Antenna:

Antenna Array, Broad side array, end fire array, principle of pattern multiplication, folded dipole, parasitic element, Yagi antenna, antenna with parabolic reflector, Horn antenna.

### UNIT - II

#### **Radio Waves Propagation:**

Communication Frequency Bands, Electromagnetic radiation in free space, surface wave attenuation and horizontal polarization, waves propagation modes at the different frequency bands, effect of curvature of the earth on ground wave propagation. Space wave propagation, atmospheric ducting, non standard troposphere micro wave and millimetre wave scatter propagation, attenuation by rain, fog, snow, ice and atmospheric gases.

Sky wave propagation through the ionosphere, critical frequencies, effect of the earth's magnetic field on sky wave propagation, dielectric constant of ionized gas, Maximum Usable Frequency, skip distance, Height of reflection of radio waves, Faraday rotation

### UNIT – III

#### **Communication Systems:**

(a) Angle Modulation:

Narrow band, Wide band and multiple frequency modulation, square wave, linear and non linear modulation, remarks only on Phase Modulation, power contents of carrier and side bands in Angle modulated carriers, Noise reduction characteristics of angle modulation, generation and demodulation of FM waves.

(b) Pulse Modulation and Digital Communication:

Pulse Amplitude Modulation, other forms of Pulse Modulation, TDM, FDM, bandwidth requirement for transmission of PAM signal , coded system and its comparison with uncoded system, sampling theorem, quantisation, efficiency of PCM system, elements of digital communication ,detection of binary signal, the matched filter decision threshold in matched filter, maximum likelihood receiver, basic phase shift and quadrature. Modulation and demodulation.

### UNIT - IV

#### **Atmospheric Science :-**

(a) General description of the Sun, solar structure, sun's outer layers, photosphere, chromospheres, corona, solar activity and sun spot cycles, solar radiation EUV and X- rays photon flux near the earth, solar wind, flares, solar magnetic field, and interplanetary magnetic field.

(b) Atmospheric Structure and Solar radiation: Temperature structure and nomenclature of the atmosphere, atmospheric pressure, density and composition, mean molecular weight, chemical and dynamical effect, intensity of incoming solar radiation ,attenuation of solar radiation intensity, molecular absorption, scattering and albedo, radiation energetic of the atmosphere. Elementary chemical kinetics, composition and chemistry of Middle Atmosphere and Thermosphere. Radiative transfer, Thermal effects of radiation. Photochemical effects of radiation. Modelling of radiative effects of Aerosols. Stratospheric chemistry of Ozone.

### UNIT – V

## Atmospheric Science Measurements and Techniques

- (a) Photochemical process in the ionosphere and morphology of different regions, the balance of ionization and production of ionization, Chapman theory for grazing incidence, corpuscular ionization, reaction, chemistry and morphology of D-region, E-region and F-region, ionospheric irregularities. Night airglow, Day airglows, Twilight airglows.
- (b) Atmospheric Measurements ( Basic technique and principles only )  
Ionosonde, characteristics of transmitter and receiver, recording of ionograms, interpretation of ionograms and determination of N(h) profile, Absorption Measurement Technique ( A-1 technique), Ionospheric Irregularities study using Closely Spaced Receiver Technique and Ionospheric Scintillation.. Measurement of Total Electron Content using Satellite based technique. Coherent and Incoherent Scatter Radar for ionospheric studies, MST Radar system, Lidar, (overview and technological feature), sunphotometer for measurement of Total Ozone Content, Water Vapour Content and Aerosols.

### Reference Books:-

1. Solar Terrestrial Physics , A K Asofu and Chapman.
2. Aeronomy of the Middle Atmosphere , Guy Brasseur and Susan Solomon.
3. An Introduction of Atmospheric Physics , G. Fleagle, Joost ,A. Businer.
4. Minor Constituents in the Middle Atmosphere, Tatsuo Shimazaki.
5. The Upper Atmosphere and Solar and Terrestrial Reactions, J.K.Hargreaves.
6. Electromagnetic waves and Radiating System , Jordan
7. Antennas and Radio Wave Propagation , R.E. Collin.
8. Electronics Communication Systems, B.P.Lathi.
9. Electronics Communication , Kennedy.
10. Digital Communication , J.J.Proakis.
11. Introduction of Ionospheric Physics, Rishbeth and Garriot.

12. Space Physics , S. Deogonkar.

## **Paper IVD: Informatics and Computer Visualization**

### Unit-I

Introduction to Information Theory and Queuing theory, Data communication: Theoretical model of communication, Application of Fourier series and Fourier transforms in data communication. Analog/Digital communication, Serial/Parallel, Simplex/Duplex, Synchronous/Asynchronous, Bit/ baud rates. Parity and error control. Signal to Noise ratio

Modulation types, techniques and standards of digital signals. Base band and carrier communication, detection, Interference, Noise signals and their characterization, Phased locked loops. Introduction and evolution of telecommunication. Transmission media: Twisted pair, cable, Optical fiber, wireless, satellite and infrared.

Computer Hardware basics, CPU, Memory and I/O devices used in Modern computers. Computer buses and Standards, Common Interface Standards: RS 232C, Centronics, USB . Modems.

### Unit-II

Computer Networking: Network types and architecture(Broadcast, Multicast, LAN,MAN, WAN, topology) Protocols, Interfaces and services, X.25,ISDN,ATM,VPN,Frame relay, wireless transmission. OSI and TCP/IP models. Bridges, switches and Routers. Routing, congestion and flow control, tunneling. Data Link protocols, Multiple access protocols, TCP,UDP, transport layer error recovery, application layer services and protocols. IP addressing ,Network security.

### Unit-III

Evolution of Internet, Internet architecture: goals and key issues related to Internetworking technologies, Internet connectivity (dial up,dedicated lines, board band,DSL,radio, VSAT). Domain Name Scheme, technology and tools relevant for Web access, Internet security.

Multimedia, techniques of data compression, voice, video, Interactive video on demand over the Internet, mobile computing. Fundamentals of Network Management (Basic concepts only)

#### Unit-IV

Object Oriented Programming concepts: ( C++ or Java language may be used to teach the concepts)Classes , Data Abstraction and Objects, Inheritance, recursion. Java Applets, creation of custom components, Images and threads

#### Unit-V

Introduction to computer graphics, applications,hardware and software. Fundamental ideas behind modern computer graphics. Two dimensional Graphics: Line, circles, ellipses translation, rotation, scaling and shearing. Shading methods. Introduction to virtual environments, Basic technologies, methodologies for processing digital images by computer.

Computer visualization: Visualization, information Visualization, Scientific Visualization. Scientific Visualization Techniques, Analysis Data for Visualization

Scalar Visualization Techniques, Applications of Visualization to Design and Analysis

Case studies:

Computer Networks ,Tannanbauem, PHI

Handbook of Virtual Environments. Kay Stanney, ed., Lawrence Erlbaum Associates, 2002

### **Paper- IV E: Advanced Digital Electronics**

## UNIT-1

Boolean Algebra and Logic gates: Axiomatic definition, basic theorems and properties, Boolean functions, canonical and standard forms, simplification of Boolean functions-two, three, four, five and six variable maps, product of sums, NAND and NOR and other two level implementations, Don't care and tabulation method. Digital Integrated circuits, Digital logic gates, IC digital logic families and its characteristics

Combinational Logic: Design procedures, adders, subtractors, code conversion, multilevel NAND and NOR circuits, Exclusive-OR and equivalent functions, Combinational logic with MSI and LSI circuits, binary parallel adder, decimal adder, magnitude comparator, decoders, multiplexers, ROM, PLA

## UNIT-II

Sequential Logic : Flip-Flops, triggering of Flip-Flops, analysis of Clocked sequential circuits, state reduction and assignment, Flip-Flop excitation tables and design procedure, design of counters Design with state equations

## UNIT-III:

Registers: Register with parallel load, Shift registers. Serial transfer, bi-directional shift register with parallel load, serial addition

Ripple Counters: Binary up-Down counters, Binary counters with parallel load, timing sequences and Johnson counter

Memory Unit: Memory Read/Write operations, random Access memory, Integrated circuit memory, magnetic core memory

Register Transfer Logic : Inter Register transfer , bus transfer, memory transfer, arithmetic, logic and shift micro operations. conditional control statements, fixed point binary data, over flow, arithmetic shifts, decimal data, floating point data, non-numeric data, instruction codes, instruction code formats, design of a simple computer

## UNIT-IV

Microprocessor Architecture and Microcomputer systems: Microprocessor architecture and its operation, memory, input and output, a computer system, logic devices for interfacing

The 8085 Microprocessor: pinout and classification of signals, Microprocessor communication and bus timings, control signal generation, functional block diagram of 8085 microprocessor, the ALU, the 8085 based microcomputer

system, machine cycle and bus timings, Op-code fetch machine cycles, memory read/write machine cycles, memory interfacing

Programming 8085: Registers, accumulator, flags, program counter and stack pointer, instruction classification, instruction formats, op-code format

The 8085 Instruction Set: Data transfer instructions, arithmetic instructions, logical instructions, branch instructions, machine control instructions, addressing modes

Assembly Language Programming: Simple programmes (including loops, counters, indexing and time delay techniques) of about 50 byte length, stack and subroutines

#### UNIT-V

Interfacing Peripherals and Applications: Basic interfacing concepts, interfacing devices, I/O mapped I/O and Memory mapped I/O

The 8085 interrupts: RST instructions, multiple interrupts and priorities, vectored interrupt

Interfacing Data Converters: Basic concepts only A/D and D/A conversion techniques and converters

Programmable Devices: Block diagram, chip enable/select logic, port address, control word/status word formats and definitions of 8155/8156, 8355/8755, 8279, 8255, 8253 and 8259 programmable devices

Serial I/O and Data Communication: Basic concepts of serial I/O, RS 232C, standard, Serial I/O using programmable chips, data Communication buses-S-100 bus, IEEE488 bus and CAMAC standard

Microcontrollers: Different types, processor architecture, microcontrollers memory types, features of microcontrollers, 8051 processor architecture

#### Recommended Books:

1. Digital Logic and Computer design by M.Morris Mano, PHI New Delhi, 1989
2. Microprocessor Architecture, Programming and applications with 8085/8080A by Gaonkar, Wiley Eastern Ltd, New Delhi 1988

## Paper-IVF:X-ray & Nuclear Spectroscopy

### UNIT-I

X-ray spectroscopy: Nature of X-ray emission and absorption spectra, Mosely's law, energy levels, selection and intensity rules, fine structure of X-rays, spin doublets, irregular doublets, multiple structure and satellite, explanation of absorption spectra.

Pair production, coherent scattering, incoherent scattering, Compton effect, internal conversion and Auger effect.

Application of X-ray in condensed Matter

Experimental methods to determination of crystal structure: cubic and non cubic crystals ( powder method), Crystal structure of single crystals. Powder spectra analysis

X R F method for elemental analysis.

### UNIT-II

Scintillation Spectrometry: Choice of detectors, properties of different organic and inorganic scintillators, Geometry, disturbing influences on gamma-ray spectra, determination of response function, analysis by peeling method, total absorption spectrometer, anti compton shields, measurements of beta ray spectra.

Semiconductor Detectors: Si(Li),Ge(Li), HPGe, Guard ring structure detectors, semiconductor detector applications in reaction charged particle, alpha particle, electron, gamma and neutron spectroscopy.

Beta-Ray Spectrometry: Design and working of semicircular, double focusing and sector type spectrometers

### UNIT-III

Nuclear Instrumentation:

Photomultipliers: General characteristics, Design of voltage divider circuits, noise. Current and voltage pulses and shapes.

Preamplifiers: Voltage, Current and charge sensitive preamplifiers, Noise sources and characteristics, connection between detector and preamplifier, selection of components for low noise performance, selection of preamplifier.

Amplifiers: Pulse shaping- RC, Gaussian, delay line circuits, pole zero cancellation, Base line restorer, pile up rejection. Amplifier specifications and types.

Pulse Amplitude Analysers: Discriminators, SCA, analog to digital conversion, multichannel analysers. methods of processing digital data. Standardisation in nuclear electronics-NIM and CAMAC standards, brief idea of electronics for 4( gamma detector system

Coincidence techniques: coincidence techniques, chance, true and true to chance coincidence ratio, resolution correction for chance coincidence, slow fast coincidence system.

Timing Techniques: Loss of resolution, jitter, walk. Constant fraction discrimination, Time to amplitude converter, Timing with scintillation and semiconductor detectors.

#### UNIT-IV

.Nuclear Spectroscopic Methods:

Disintegration schemes: General procedures- preparation of source material, calibration of instruments, search for (-rays and measurement of their energy, determination of relative intensity, measurement of (-rays, Fermi plots.

Life Time Measurements: Direct timing methods, delayed coincidence and centroid shift, recoil and Doppler shift methods.

Resonance Fluorescence of Gamma-Rays: Resonance scattering of (- rays. Cross-section (No derivation),survey of experimental methods. Mossbauer spectroscopy: Basic aspects, principle and theory, Lamb-Mossbauer factor, experimental procedure, Mossbauer parameters-isomer shift, quadrupole and magnetic splitting. Applications of Mossbauer effect in Nuclear Physics

Internal Conversion: Role of internal conversion in nuclear spectroscopy, Internal conversion studies at very high resolution- Multipolarities from conversion line intensity ratios, application to nuclear level schemes. Natural widths of conversion lines, relative and absolute energy standards. Classification of nuclear transition rates.

#### UNIT-V

Angular Distribution of Nuclear Radiation: Naive theory of gamma-gamma directional correlation of a free nuclei, theoretical results of gamma- gamma and Beta-gamma direction correlation, experimental procedures, influence of extra nuclear fields, General theoretical description (No derivation). Attenuation coefficients for static electric, magnetic and combined interaction (No derivation) Determination of g-factors of excited nuclear states and determination of static

quadrupole coupling. Time dependent perturbation( elementary ideas) brief introduction to Nuclear orientation and in beam gamma ray spectroscopy.

Recommended Books:

- 1.X-ray diffraction procedures ,Klug and Alexander
- 2.Elements of X-ray diffraction, Cullity
- 3.Powder Method in X-ray crystallography, Azaroff.
- 4.Alpha,Beta and Gamma ray Spectroscopy, Vol I & II, Kai-Siegbahn, North Holland, 1975
- 5.Perturbed Angular correlation, Karlson,Mathias an Siegbahn
- 6.Mossbauer Effect ,Weirtheim
- 7.Radiation Detector Systems, edited by S.K.Kataria, Oxford Publishing Co.,1992

### **Paper-IVG:Advanced Solid State Physics**

#### UNIT-I

Group of solid state and molecular Physics:

Point group of first and second kind, character table and representation methods to generate lattice in two and three dimensions, space groups, their nomenclature and classification, semi direct product and the concept of symorphic

groups. Assymorphic groups. Special point of the Brillouine zone, space group representations, A two dimensional example, method of character of space groups.

#### UNIT-II

Double Groups and their Representations:

Time reversal symmetry and Kramer degeneracy, introduction to the enumerations and classification of magnetic point groups and space groups and their characters.

Symmetry Groups:

Permutational symmetry, Youngs diagrams,tableau and Hook Yamanochi symbols,irreducible representations and their Kronecher reduction. Application to normal modes of vibrations of molecules(simple selection rules for infrared and Raman transition) basic function and Microscopic crystal tensors.

### UNIT-III

#### Electron Phonon Interaction.

The deformation Potential Interaction, polarons, phonon cloud, relaxation time, interaction with longitudinal optical phonons, Polaron effective mass, electron interaction in metals.

#### Transport properties:

The Boltzman equations, electrical conductivity, relaxation time, impurity scattering, ideal resistance, thermal conductivity, thermo electric effects, lattice conduction, phonon drag, magneto resistance, influence of open orbits.

### UNIT-IV

#### Superconductivity:

Indirect electron-electron interaction via phonons, bound electron pairs in Fermi gas, BCS reduced Hamiltonian, solution of the BCS equation by computation of motion method, Electrodynamics of superconductors, coherence length, quantised magnetic flux in superconductors.

#### Binary alloys:

Lause theorem, Friedel sum rule, rigid band theorem, electrical resistivity, long range oscillation of electron density, virtual states, localised magnetic states in metals. Anderson model, indirect exchange interaction via conduction electrons.

### UNIT-V

#### Neutron Diffraction by Crystals:

Born approximation, differential scattering cross section and density correlation function, coherent and incoherent elastic nuclear scattering, electronic and magnetic scattering of neutrons, Elastic paramagnetic and ferromagnetic scattering.

#### Mossbauer Effect:

Background concepts: Natural line width, Recoil Energy Loss, Resonance and Resonance Fluorescence, Doppler Broadening, Einstein Solids, Recoil-free emission of gamma rays, Mossbauer effect and its Observation, Theory of Mossbauer effect, Mossbauer Spectrometer, source and absorber, Mossbauer spectra and parameters.

#### Recommended Books:

1. Quantum Theory of Solid-Kittel
2. Quantum Theory of Solid-Ziman
3. Group Theory in Solid state Physics- Falicov

3. Group Theory and its applications in Physics-Hammermesh.
4. An introduction to Mossbauer Spectroscopy- L.May, Plenum press

### **Paper-IVH: Quantum Field Theory**

#### UNIT-I

Photon and Electromagnetic field

Particles and field, the electromagnetic field in the absence of charges, the classical field, harmonic oscillator, the quantized radiation field, the electric dipole interaction, the electromagnetic field in the presence of charges. Classical electrodynamics, Quantum electrodynamics, radiative transitions in atoms, Thomson scattering, The Schrodinger, Heisenberg interaction pictures.

Langrangian Field Theory:

Relativistic notation, Classical Langrangian field theory, Quantised Langrangian field theory, symmetries and conservation laws.

#### UNIT-II

The Klein Gordan Field:

The real Klein-Gordan field, The complex Klein Gordan field, Covariant commutation relation, the meson propagator.

The Dirac field:

The number representation for fermions, The Dirac equation, second quantization, The fermion propagator, The electromagnetic interaction and gauge invariance.

Photons covariant theory:

The classical field, covariant quantisation, the photon propagator.

#### UNIT-III

The S-matrix Expansion:

Natural dimensions and units, The S-matrix expansion, Wick's theorem.

Feynman Diagrams and Rules in QED:

Feynman diagrams in configuration space, Feynman diagrams in momentum space, The first order terms, Compton scattering; Electron-electron scattering, closed loops, Feynman rules for QED; Leptons.

QED Processes in Lowest Order:

The cross section, Spin sums, Photon polarization sums, Lepton pair production in  $(e+q)$  collisions, Bhabha scattering, Compton scattering, Scattering by an external field, Bremsstrahlung, The infra-red divergence

#### UNIT-IV

Radiative Corrections:

The second order radiative correction of QED, The photon self energy, The electron self energy, external line renormalization, the vertex modification, application, the anomalous magnetic moments, the Lamb shift. The infra-red divergence. Higher order radiative corrections, renormalizability.

Regularizations:

Mathematical preliminaries, Some standard integrals, Feynman parameterization, cut-off regularization, the electron mass shift, dimensional regularization, introduction, general results, vacuum polarization, the anomalous magnetic moment.

Weak Interactions:

Introduction, leptonic weak interactions, the free vector Boson field, the Feynman rules for the IVB theory, decay rates. Applications of IVB theory, Muon decay, Neutrino scattering, the leptonic decay of the W Boson. Difficulties with the IVB theory.

Gauge theory of Weak Interaction:

The simplest gauge theory, QED, Global phase transformations and conserved weak currents, the gauge invariant electro-weak interaction, properties of the gauge Bosons, lepton and gauge Boson masses, Two gauge transformation results, the transformation law. The SU(2) gauge invariance.

Spontaneous Symmetry Breaking:

The Goldstone model, the Higgs model, the standard electro-weak theory.

The Standard Electro-Weak Theory:

The Lagrangian density in the unitary gauge, Feynman rules, elastic neutrino-electron scattering, electron-positron annihilation, the Higgs Boson.

Recommended Books:

1. Quantum field theory, Mandl and Shaw, John-Wiley & Sons, 1984.

## **Paper-IV I ASTRONOMY AND ASTROPHYSICS**

### **UNIT-I**

#### **Astronomy and Astrophysics :**

Basic parameters in Astronomical observations (Magnitude scale, Coordinate system)-  
Stellar classification- H.R.D Diagram- Saha's equation –Jean's criteria for stellar formation-  
Stellar Evaluation-Galaxy Classification.  
Cosmology: Cosmological models-observations- cosmic violence (in nucleus of the Galaxy ) – Cosmic background radiation- Elementary particles and cosmos - Big-Bang  
Model –inflationary Universe (flatness and horizontal problem) – Relativistic and cosmic  
Geometry of space – time and universe –Bios and cosmos (Genesis of life on the earth-solar System-comet-milky –way as an abode of life ).

#### **Unit-II**

#### **Astronomical Instruments and Observation Techniques:**

Telescopes- f /no.-Plate Scale – Types of Telescopes-seeing Conditions – Diffraction  
Limited Resolution – Photometer- Spectrometers (Interferometers, Gratings ) –Imaging  
Detectors (MCPs, CCDs, and Ir Arrays ) – High angular Resolution Techniques (Speckle, Lunar Occultation , adaptive optics).

#### **Unit-III**

#### **Optical and near IR studies of Stars and Galaxies :**

Spectral Energy Distribution ( in Optical and Bands ) in Stars – Rotation fo stars – Study of  
Binary Stars – Gaseous Nebulae – Extinction curve of Interstellar Matter-dust- Rotation  
Curve of galaxies – Spectral Energy Distribution – Coloer –Color Studies ( Imaging of Galaxies in Different bands )

## UNIT-IV

### High Energy astronomy

Atmospheric transmission- Detection Techniques for X –rays and Gamma –rays –X- ray

Telescopes- Imaging and Spectroscopy- Radiation Processes- Accretion Disks in Black

Holes and X- rays Binaries- Active Galactic Nuclei.

Dark Matter : Evidences of dark matter- Dark matter components in our galaxy- in Halos

Of the spiral galaxy- in clusters of candidates in darkmatter .

-Baryonic and non- Baryonic candidates in darkmatter .

Star evolution : White and brown Dwarf – Neutron star –Super nova- pulsars- Black Holes.

## UNIT-V

### Multi wave – length detection techniques in Astronomy

Radio Telescopes- Aperture System- IPS Technique – Very long Base Interferometry

(VLBI)- Pulsars – Radio galaxies – Distribution of H1 gas in Galaxies – Radiation

mechanisms.

Black hole Observation (Gravitational lens – Schwarzschild radius – Singularity),

X-rays and Gamma rays bursters through cosmic flux detection using photo – multipliers

Tubes – Hubbles ‘ law and Hubbles’ constant ( Red shift – distance -age of the Universe

Measurements ) – Galactic Structure – Rotation and spiral (Optical – radio – X –rays – Gamma radiation observation ).

### Text Books

J. D . Kraus, W.N. sen, J.A.Hoegbom, M.Kundu

M. Longair , J.K. Davis

K.D Abhayakar , F. Shu, M. Harwit

C.R . Kitchin , I. McLean, G.Walker

## PAPER V : Practical-I:Nuclear Physics Practicals

### Note:

1. Students are required to do at least ten experiments
2. Students are required to give at least one seminar on experiments allotted to them.

### LIST OF EXPERIMENTS

- 1 Study of absorption coefficient for gamma-rays
2. Determination of end point energy of alpha particles
- 3.Determination of the range and energy of alpha particles using spark counter.
- 4.Determination of end point energy of beta rays
- 5.Study of gamma-ray spectra using scintillation spectrometer (a) Calibrate a scintillation spectrometer (b) Measurement of unknown energy (c) Study of energy resolution
6. Coincidence circuit (a) Determination of resolving time (b) Determination of strength of Co-60 source
7. To determine the operating voltage, slope of the plateau and dead time of a G. M. counter.
8. Determination of dead time of G.M counter system
9. Study of G.M counter and random events
- 10.** Feather' analysis using G.M. counter.
11. Study of Proportional detector (a) Calibrate proportional counter system (b) Study of resolution
12. Study of X-ray Laue pattern of cubic crystals
13. Study of X-ray Debye Scherer Powder spectra of cubic materials.
- 14.** To determine the operating voltage of a photomultiplier tube and to find the photopeak efficiency of Na (TI) crystal of a given dimensions for gamma rays of different energies.
- 15.** To determine the energy resolution of a NaI (TI) detector and to show that it is independent of the gain of the amplifier.

16. To calibrate a gamma ray spectrometer and to determine the energy of a given gamma source.
17. To determine the mass attenuation coefficient of gamma rays in a given medium.
18. To study the Compton scattering using gamma rays of suitable energy.
19. To study the various modes in multichannel analyzer and to calculate the energy resolution, energy of gamma ray.
20. To determine the beta ray spectrum of Cs-137 source and to calculate the binding energy of K -shell electron of Cs-137.
21. To study Rutherford scattering using aluminium as scatterer and Am-241 as a source.
22. To measure the efficiency and energy resolution of HPGe detector.
23. Alpha spectroscopy with surface barrier detector-energy analysis of an unknown gamma source.
24. The proportional counter and low energy X-ray measurements.
25. X-ray fluorescence with a proportional counter,
26. Neutron activation analysis.
27. Identification of particles by visual range in nuclear emulsion.
28. Construction and testing of a single channel analyzer circuit.
29. Decoding and display of the outputs from the IC-7490.

### **Paper VIA: Practical-II: Condensed Matter Physics**

- 1 Students are required to do at least ten experiments
2. Students are required to give at least one seminar on experiments allotted to them.

### **LIST OF EXPERIMENTS**

1. Measurement of lattice parameters and indexing of powder patterns.
2. Determination of orientation of crystal by back reflection Laue method
3. To prepare and X-ray characterization of a compound/alloy
4. Determine Curie temperature of a ferromagnetic material
5. To determine magnetoresistance of a bismuth crystal
6. To grow and X-ray characterization of organic crystal

7. To prepare and study superconducting material
8. Study of Hall effect
9. Study of simulation of dispersion of phonons in simple systems
10. To study the thermal diffusivity of Teflon
11. Analysis of neutron diffraction data
12. Measurement of A.C susceptibility
13. Measurement of electrical conductivity
14. Study of any iron containing material by Mössbauer effect
15. Measurement of dielectric constant
16. Band Structure Calculations

### PAPER - VI B (PRACTICAL-II ) Non-Linear Physics and Chaos Lab

1. Students are required to do at least eight experiments
2. Students are required to give at least one seminar on experiments allotted to them.

#### LIST OF EXPERIMENTS

1. Using a P.C. , experimentally find the first four critical values for period doubling , in the logistic equation :

$$X_{n+1} = \lambda X_n (1 - X_n)$$

Find the first two approximation to the Feigenbaum number.

2. A dynamical system that exhibits period doubling and chaos is the set  
Of three first order differential equation (Rosler).

$$\dot{X} = -y - z, \quad \dot{Y} = x + ay, \quad \dot{z} = b + z(x - c)$$

Choose  $b=2$ ,  $c=4$ , and explore the parameter require  $0.3 \leq a \leq 0.4$

And look for period doubling. For the case  $a=0.398$ , plot a return  $X_{n+1}$  vs  $X_n$  map. Compare with the logarithmic equations.

Comment [s1]:

3. A return map,  $X_{n+1}$  show a bilinear relationship.

$$F(x) = a + bx \quad X < 1$$

$$c - dx \quad X > 1$$

if  $b > 0, d > 0$  show that the Lyapunov exponent is positive when  $b, d > 1$ . Sketch a few iterations of the map in the  $(X_{n+1}, X_n)$  plane.

4. A damped harmonic oscillator can be represented mathematically by the following differential equation and solution:  $\ddot{x} + 2r\dot{x} + \omega^2 x = 0$

$$x(t) = c_0 e^{-2rt} \cos(\sqrt{\omega^2 - r^2} t + \phi_0)$$

Sketch the solution in the phase plane  $(x, \dot{x})$ . Define a Poincaré

Section when  $x > 0, \dot{x} = 0$ . Assume that  $r$  is small ( $r^2 \ll 1$ ) and

Show that the resulting map takes the form:

$$X_{n+1} = \lambda X_n \quad \text{and} \quad \lambda < 1$$

5. Investigate the properties of the cubic map

$$X_{n+1} = Y_n \quad Y_{n+1} = -b_{x_i > n} + d_{y_i > n} - y_n^3$$

Find the fixed points and determine their stability as a function of

The parameters  $b, d$ . Iterate this map for  $b = 0.2, d = 2.5, 2.65, 2.77$ .

6. Investigate the fixed points and stability as a function of the control parameter of the cubic map:

$$X_{n+1} = \lambda X_n (1 - X_n^2)$$

7. Use P.C. to enumerate the critical values of in the logistic

Equation:

$$X_{n+1} = \lambda X_n (1 - X_n)$$

and show that the sequences of values  $\lambda_n$  and  $n$  approach the universal number :

$$\lim_{m \rightarrow 0} \frac{\lambda_{m+1} - \lambda_m}{\lambda_{m+1} - \lambda_m} = -1 \quad \delta = 4.6692$$

Another first-order iterated map that exhibits period doubling is the sine map

$$X_{n+1} = \lambda \sin X_n, \quad 0 \leq X_n < 1.$$

Lim

Show that this map exhibits a period doubling sequence and verify

That:

$$\lim_{m \rightarrow 0} \frac{\lambda_{m+1} - \lambda_m}{\lambda_{m+1} - \lambda_m} = -1$$

$$m \rightarrow 0 \quad \lambda_{m+1} - \lambda_m \quad \delta = 406692$$

## **PAPER VI C: Practical –II: COMMUNICATION ELECTRONICS AND AERONOMY PRACTICALS**

### **LIST OF EXPERIMENTS**

1. To study the Amplitude Modulated wave and detection of AM waves.
2. To study the Frequency Modulated Wave and its detection.
3. To study the Pulsed Coded Modulated and its detection.
4. To study the polar diagram for antennae.
5. To find (a) frequency of a wave (b) standing wave ratio by Letcher Wire
6. Determination of apparent height of ionosphere layer.
7. Measurement of Solar UV- B and Infra red radiation and determination of Total Ozone , Water Vapour and Aerosols.
8. Study of characteristics of Klystron.
9. To study of characteristics of Radio Receiver.
10. Measurement of VHF Satellite Signal for ionospheric scintillation studies.

### **Paper VID: Practical-II: Informatics and Computer Visualization**

#### **Section-A: Computer Hardware and Networking**

- 1.To study PCM-TDM , TDM-PAM
- 2.To study frequency modulation
- 3.To study sampling and Reconstruction (TDM-PAM)
- 4.To study delta modulation, adaptive delta modulation, sigma modulation and demodulation techniques
- 5.To study PSK,QPSK modulation Techniques
- 6.To study computer boards, cards,devices and RS 232 ,USB Interfacing,
- 7.To generate PAM Wave form
- 8.Optical Communication (Optical Fiber based Experiments)
- 9.Design and study of a structured network
- 10.Study of Router system
- 11.Configuration and study of Network Operating systems

## **Section-B: Computer Graphics and Visualization**

1. Computer Programming using C++
2. Using Java Applets
3. Programming drawing lines ,circles and ellipses using c++
4. Translation,rotation, filling, shearing of objects
5. Using MATLAB for Visualization

### **PROJECTS**

Students are required to undertake project work on Computer Networking or Computer Graphics and Visualization.

## **Paper-VIE: (PRACTICAL-II) Advanced Digital Electronics Practicals**

### **LIST OF EXPERIMENTS**

#### **Section -A (Laboratory experiments)**

1. Design and study of BCD to seven segment decoder circuit and 4&16 decoder circuit
2. Design and study of 4 bit full adder
3. Design and study of 4 bit register with parallel load and design and study of 4 bit bidirectional shift register
4. Microprocessor programming using trainer kit and Machine coding
5. Assembly language programming using assembler for 8085
6. Interfacing Analog to Digital Converter with Microprocessor
7. EPROM Programming
8. Interfacing Memory with Microprocessor
9. Interfacing Display with Microprocessor
10. Study of decoder circuits for microprocessor

## **Section-B**

Candidates are required to complete one project and submit it in the examination with a project report:

List of projects:

1. Temperature controller
2. 8 bit analog to digital converter
3. Microprocessor controlled display
4. Signal generator
5. Stepper motor controlling
6. Serial communication between Pc/XT and Microprocessor trainer
7. Digital Voltmeter
8. Digital frequency meter
9. Data Acquisition system
10. Digital IC tester

## **Paper VIF (PRACTICAL-II):X-ray and Nuclear Spectroscopy Practicals**

### **LIST OF EXPERIMENTS**

1. Study of X-ray Debye-Scherrer powder pattern of non-cubic crystals
2. X-ray diffraction powder pattern analysis
3. Study and analysis of Gamma-ray Scintillation spectra
4. Study of Mossbauer effect
5. Study of angular correlation of gamma-rays
6. Design and study of pulse shaping circuits
7. Design and study of photo multiplier tube voltage divider circuits
8. Design and study of voltage and charge sensitive preamplifiers
9. Design and study of decade counter circuits
10. Study of performance of an analog to Digital converter
11. Study and Analysis of semiconductor detector gamma spectra
12. Study and analysis of beta ray scintillation spectra
13. Study of life time of excited state of Ta-181.

Paper - VIG ( PRACTICAL –II)

ADVANCED SOLID STATE EXPERIMENTS

SECTION – A

( Students are required to do at least five experiments from this section ).

1. X-ray diffraction studies of cubic and non – cubic crystals by Powder method .
2. Orienting single crystals with the help of X – ray diffraction.
3. Resistivity measurement of a material ( compound ) at different Temperatures using four probe method .
4. preparation of a compound and a binary alloy and measuring its conductivity.
5. Study of a superconducting material – Resistivity at low temperature
6. Determination of Curie temperature of a ferromagnetic material.
7. Mossbauer study of iron compound at room temperture.

SECTION-B

(COMPUTATIONAL)

Students are required to do at least five computational problems based On topics covered in the optional paper IV G

PAPER – VI H ( PRACTICAL –II) QUANTUM FIELD THEORY

NOTE: Students who offer paper IV H as optional paper  
Are required to offer Paper VIH

COMPUTATIONAL LAB

Students are required to learn to learn one computer language and perform at least 10 computational problem based on the topic covered in the optional Paper IVH

## **Paper VI I: Pratical-II ASTRONOMY & ASTROPHYSICS LAB**

### **LIST OF EXPERIMENTS**

1. Detection of Secondary Cosmic radiation using ground based Scintillation counters.
2. Study of High- energy Cosmic flux bands.
3. Determination of Primary Cosmic flux energy from energy spectrum of Secondary cosmic radiation .
4. Study of image processing of Stellar objects using Charge Coupled Device (CCD ) camera.
5. Experiment with a slit, prism, and sunlight to produce a spectrum to identify dark Lines of H, Ca., Fe and Na.
6. Study of well defined dark lines in continous spectrum of full Moon.