

**BHARATHIAR UNIVERSITY, COIMBATORE-641 046**  
**M. Sc. PHYSICS DEGREE COURSE**  
**(AFFILIATED COLLEGES – CBCS PATTERN)**  
**(For Candidates Admitted During the Academic Year 2010-2011 Batch & Onwards)**  
**SCHEME OF EXAMINATIONS**

Semester	Study Components	Ins. Hrs/	Exam				Credit
			Dur. Hrs.	CIA	Unit. exam	Total Mark	
<b>I</b>	Paper – I Classical Mechanics	5	3	25	75	100	4
	Paper – II Mathematical Physics	5	3	25	75	100	4
	Paper – III Quantum Mechanics-I	5	3	25	75	100	4
	Paper – IV Advanced Computational Physics	5	3	25	75	100	4
	Practical – I General Physics	3	-	-	-	-	-
	Practical – II Electronics	3	-	-	-	-	-
	Elective I	4	3	25	75	100	4
<b>II</b>	Paper – V Quantum Mechanics-II	5	3	25	75	100	4
	Paper – VI Electromagnetic Theory	5	3	25	75	100	4
	Paper –VII Electronic Devices	5	3	25	75	100	4
	Practical- I General Physics	5	4	40	60	100	4
	Practical- II Electronics	5	4	40	60	100	4
	Elective II	5	3	25	75	100	4
<b>III</b>	Paper – VIII Experimental Techniques & Data Analysis	5	3	25	75	100	4
	Paper – IX Nuclear & Particle Physics	5	3	25	75	100	4
	Paper – X Spectroscopy	5	3	25	75	100	4
	Paper – XI Communication Electronics	5	3	25	75	100	4
	Practical- III Advanced Practicals	3	-	-	-	-	-
	Practical- IV Special Electronics	3	-	-	-	-	-
	Elective III	4	3	25	75	100	4
<b>IV</b>	Paper –XII Condensed Matter Physics	5	3	25	75	100	4
	Paper –XIII Thermodynamics & Statistical Physics	5	3	25	75	100	4
	Paper –XIV Plasma Physics	5	3	25	75	100	4
	Practical- III Advanced Practicals	5	6	40	60	100	4
	Practical- IV Special Electronics	5	6	40	60	100	4
	Project	5	-	-	-	150*	6
Total						2250	90

\* Project report – 80% marks; Viva-voce – 20% marks

**List of Group Elective papers (Colleges can choose any one of the Grouppapers as electives)**

	GROUP A	GROUP B
Paper I/ Sem I	Fundamentals of Nanoscale Science	Introductory Astronomy And Astrophysics
Paper II/ Sem II	Nanomaterials Synthesis	Introductory Cosmology
Paper III/ Sem III	Characterization and Application of Nano Materials	Astronomical Techniques

## FIRST SEMESTER

### PAPER I – CLASSICAL MECHANICS

#### UNIT 1: Lagrangian Formalism:

Constraints and degree of freedom- Generalized coordinates: Generalized Displacement, Acceleration, Momentum, force & Potential- Variation techniques and Euler's Lagrange differential equation- Hamilton's Variational principle- Lagrange's equation of motion from Hamilton's principle- Deduction of Newton's second law of motion from Hamilton's principle- Application of Lagrange's equation of motion: Linear harmonic oscillator- Simple pendulum- Isotropic oscillator- Particle moving under central force- Conservation theorems: Cyclic coordinates- Conservation of Linear momentum- Conservation of energy.

#### UNIT II: Hamiltonian Formalism:

Phase space- Hamiltonian- Hamilton's canonical equation of motion- Significance of H- Deduction of canonical equation from Variation principle- Application of Hamilton's equation of motion: Simple pendulum- Particle in a central field of force- Hamiltonian of a Charged particle in an electromagnetic field- Principle of least action and proof- Canonical transformations- Generating function and different forms

#### UNIT III: Hamilton –Jacobi Method:

Hamilton Jacobi method, Solution of harmonic oscillator by HJ method- Particle falling freely- Kepler problem- Damped harmonic oscillator- HJ theory for geometric optics and wave mechanics- Poisson's brackets- Definition- Equation of motion in Poisson's bracket form Poisson theorem(Jacobi Identity)- Angular momentum and Poisson's Brackets.

#### UNIT IV: Two Body Problem and Relativity:

Equivalent One body problem- General Features of central force, motion- Stability of orbits and Conditions for closure- Motion under inverse square law Shapes of orbits- Inertial/Non inertial frames- Rotatory Co ordinary system- Effects of coriolis force on the moving bodies\_ Basic postulates of special relativity- Lorentz transformation- Relativistic generalization of Newton's law- Lagrangian formulation of relativistic mechanics.

#### UNIT V: Rigid body dynamics & Small oscillation:

Euler theorem- Euler's angle- Angular velocity of a rigid body-Angular momentum of rigid body- Moments and products of inertia- Principle axis of transformation- Torque free motion of a rigid body- Poinsoit solutions- The motion of a symmetric top under action of gravity- Stable and unstable equilibrium- Lagrange's equation of motion for small oscillation

#### Books for Study & Reference:

1. Classical Mechanics- S.L.Gupta, V. Kumar & H.V.Sharma-Pragati Prakashan- Meerut.,2003
2. Classical Mechanics- H. Goldstein-Addison Wesley, London,1996
3. Elements of Statistical Mechanics-Kamal Singh & S.P. Singh- S. Chand & Company, New Delhi,1999.
4. Elements of Statistical Mechanics-Gupta & Kumar- Pragati Prakashan- Meerut

## FIRST SEMESTER

### PAPER II- MATHEMATICAL PHYSICS

#### Unit I: Special Functions

Legendre's Polynomials and Functions- Differential Equations and Solutions-Generating Functions- Orthogonality-Relation between Legendre Polynomial and their Derivatives-Recurrence Relations- Bessel's Function-Differential Equation and Solution-Generating Functions-Recurrence Relations- Hermite function.

#### Unit II: Complex Variable Theory

Functions of a Complex Variable-Single and Multivalued Functions-Cauchy-Reimann Differential Equation-Analytical Line Integrals of Complex Function-Cauchy's Integral Theorem and Integral Formula-Derivatives of an Analytic Function-Taylor's Variables-Residue and Cauchy's Residue Theorem.

#### Unit III: Linear Space

Definition of Vector Space-Linear Dependence-Linear Independence-Basis-Dimension of a Vector Space-Representation of Vectors and Linear Operators with respect to Basis-Schmidt Orthogonalization Process-Inner Product.

#### Unit IV: Fourier Series & Laplace Transforms

Fourier Series-Dirichlet's Theorem-Change of Interval-Complex Form-Fourier Series in the Interval(0,∞)- Uses of Fourier Series.-Laplace Transform-Definition-Properties-Translation Property-Inverse Laplace Transform-Properties

#### Unit V: Group Theory

Definition of Groups-Groups of Transformation-Multiplication Table ( $C_{4v}$ )-Subgroups and Conjugate Classes-Cyclic Groups-Symmetry Elements-Transformation & Matrix Representation-Point & Space Groups-Reducible & Irreducible Representation of a Group-Schur's Lemmas-Orthogonality Theorem- Character of a Representation & Character Table-  $C_{2v}$  &  $C_{3v}$  Groups in Molecular Physics-Application for Classification of Elementary Particles

#### BOOKS FOR STUDY & REFERENCE:

1. Mathematical Physics- Sathya Prakash-Sultan Chand & Sons
2. Mathematical Physics-B.D. Gupta-Vikas Publishing House, 3<sup>rd</sup> Edition, 2006
3. Mathematical Physics-B.S. Rajput- Pragati Prakashan- Meerut 17<sup>th</sup> Edition 2004
4. Elements of Group Theory for Physicists-A.W. Joshi-Wiley Eastern, 2002
5. Mathematical physics by P.K. Chattopadhyay-New Age International-New Delhi.
6. Mathematical Physics-P.P. Gupta, Yadav & Malik-Kedarnath Ramnath-Meerut
7. Numerical Methods in Science & Engineering-M.K. Venkataraman-National Publishing-Chennai,1986
8. Numerical Methods-A. Singaravelu-Meenakshi Publishing

#### Tutorial: Mathematical Physics (This portion is not intended for examination purpose)

- 1) Fourier Transformation (FT) of Gaussian functions.
- 2) Applications of FT of dirac delta function.
- 3) Solution of time dependent problems by FT.

## FIRST SEMESTER

### PAPER III- QUANTUM MECHANICS - I

#### **Unit I: Equation of Motion & Application of Schroedinger's Equation:**

State Vectors-Hilbert Space-Dirac Notation-Dynamical Variables as Operators-Change of Basis-Unitary Transformation-Equation of Motion in Schroedinger Picture, Heisenberg Picture & Dirac Picture.

#### **Unit II: Approximate Methods:**

Time Independent Perturbation Theory in Non-Degenerate Case-Ground State of Helium Atom- Degenerate Case-Stark Effect in Hydrogen-Variation Method & its Application to Hydrogen Molecule- WKB Approximation.

#### **Unit III: Time Dependent Perturbation Theory:**

Time Dependent Perturbation Theory-First and Second Order Transitions-Transition to Continuum of States-Fermi Golden Rule-Constant and Harmonic Perturbation-Transition Probabilities-Selection Rules for Dipole Radiation-Collision-Adiabatic Approximation

#### **Unit IV: Angular Momentum**

Orbital Angular Momentum-Spin Angular Momentum-Total Angular Momentum Operators-Commutation Relations of Total Angular Momentum with Components-Ladder Operators-Commutation Relation of  $J_z$  with  $J_+$  and  $J_-$  - Eigen Values of  $J^2$ ,  $J_z$ -Matrix Representation of  $J^2$ ,  $J_z$ ,  $J_+$  and  $J_-$  - Addition of Angular Momenta- Clebsch Gordon Coefficients-Properties.

#### **Unit V: Relativistic Wave Equation:**

Klein Gordon Equation-Plane Wave Equation-Charge and Current Density-Application to the Study of Hydrogen Like Atom-Dirac Relativistic Equation for a Free Particle-Dirac Matrices-Dirac Equation in Electromagnetic Field-Negative Energy States.

#### **Books for Study & Reference:**

1. Quantum Mechanics-Gupta, Kumar & Sharma 23<sup>rd</sup> Edition, 2003-2004
2. Quantum Mechanics-Satyaprakash
3. Quantum Mechanics-L.I. Schiff- McGraw Hill, 3<sup>rd</sup> Edition, 1968
4. Quantum Mechanics-E. Merzbacher-Wiley and Sons, 3<sup>rd</sup> Edition, 2004
5. Quantum Mechanics-A. Devanathan-Narosa Publishing-New Delhi, 2005
6. A Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan-Tata McGraw Hill. 29<sup>th</sup> Reprint, 2002
7. Principles of Quantum Mechanics-R.Shankar, Springer, 2005

#### **Tutorial: Quantum Mechanics I** (This portion is not intended for examination purpose)

- 1) One dimensional step, barrier, well.
- 2) Particle energy below and above barrier height; similarly for well.
- 3) Plotting of harmonic oscillator wavefunctions; problems involving matrix representations of an operator.

## FIRST SEMESTER

### PAPER IV-ADVANCED COMPUTATIONAL PHYSICS

#### Unit I: Numerical Differentiation

Finding Roots of a Polynomial-Bisection Method-Newton Raphson Method-Solution of Simultaneous Linear Equation by Gauss Elimination Method-Solution of Ordinary Differential Equation by Euler, Runge-Kutta Fourth Order Methods.

#### Unit II: Numerical integration

Newton's cotes formula-Trapezoidal rule-Simpson's 1/3 rule- Simpson's 3/8 rule-Boole's rule-Gaussian quadrature method-(2 point and 3 point formulae)-Giraffe's root square method for solving algebraic equation.

#### Unit III: Matlab Fundamentals

Introduction-Matlab Features-Desktop Windows: Command, Workspace, Command History, Array Editor and Current Directory -Matlab Help and Demos- Matlab Functions, Characters, Operators and Commands. Basic Arithmetic in Matlab-Basic Operations with Scalars, Vectors and Arrays-Matrices and Matrix Operations-Complex Numbers- Matlab Built-In Functions-Illustrative Examples

#### Unit IV: Matlab Programming

Control Flow Statements: *if, else, else if, switch* Statements-*for, while* Loop Structures-*break* Statement-Input/Output Commands-Function m Files-Script m Files-Controlling Output

#### Unit V: Matlab Graphics:

2D Plots-Planar Plots, Log Plots, Scatter Plots, Contour Plots-Multiple Figures, Graph of a Function-Titles, Labels, Text in a Graph- Line Types, Marker types, Colors-3D Graphics-Curve Plots-Mesh and Surface Plots-Illustrative Examples

#### Books for Study & Reference

1. Engineering and Scientific Computations Using Matlab- Sergey E. Lyshevski-JohnWiley & Sons
2. A Guide to Matlab for Beginners & Experienced Users-Brian Hunt, Ronald Lipsman, Jonathan Rosenberg-Cambridge University Press
3. Matlab Primer-Timothy A. Davis & Kermit Sigmon-Chapman & Hall CRC Press-London
4. Matlab Programming-David Kuncicky-Prentice Hall
5. Getting Started With Matlab-Rudra Pratap-Oxford University Press-New Delhi
6. An Introduction to Programming and Numerical Methods in MATLAB- S.R. Otto and J.P.Denier- Springer-Verlag-London
7. Numerical Methods Using Matlab-John Mathews & Kurtis Fink-Prentice Hall-New Jersey, 2006
8. Numerical methods in Science and Engineering- M.K. Venkataraman-National Publishing Co. Madras, 1996
9. Introductory Methods of Numerical Analysis- S.S. Sastry-Prentice Hall, 2005

## SECOND SEMESTER

### PAPER V – QUANTUM MECHANICS - II

#### Unit I: Scattering Theory

Scattering Amplitude-Expression in terms of Green's Function-Born Approximation and its Validity- Partial Wave Analysis-Phase Shifts-Scattering by Coulomb and Yukawa Potential

#### Unit II: Application to Atomic Structure

Central Field Approximation-Thomas Fermi Model-Hartree's Self Consistent Model-Hartree Fock Equation-Alkali Atoms-Doublet Separation-Intensities-Complex Atoms-Coupling Schemes

#### Unit III: Application to Molecular Structure

Hydrogen Molecule Ion-Hydrogen Molecule-Heitler London Method-Covalent Bond-Spin Orbit Interaction as Correction to Central Field Approximation- Hartree Fock Self Consistent Field Method for Molecules-Hybridisation.

#### Unit IV: Theory of Radiation (Semi Classical Treatment)

Einstein's Coefficients-Spontaneous and Induced Emission of Radiation from Semi Classical Theory- Radiation Field as an Assembly of Oscillators-Interaction with Atoms-Emission and Absorption Rates- Density Matrix and its Applications

#### Unit V: Quantum Field Theory

Quantization of Wave Fields- Classical Lagrangian Equation-Classical Hamiltonian Equation-Field Quantization of the Non-Relativistic Schroedinger Equation-Creation, Destruction and Number Operators-Anti Commutation Relations-Quantization of Electromagnetic Field Energy and Momentum.

#### Books for Study & Reference:

1. A Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan-Tata McGraw Hill 29<sup>th</sup> Reprint 2002
2. Quantum Mechanics-Gupta, Kumar & Sharma, 23<sup>rd</sup> Edition, 2003-2004
3. Quantum Mechanics-Satyaprakash
4. Introduction to Quantum Mechanics-A.K. Chandra-Tata McGraw Hill
5. Quantum Mechanics-Merzbacher-John Wiley & Sons 3<sup>rd</sup> Edition, 2004
6. Quantum Mechanics-Devanathan-Narosa Publishing-New Delhi, 2005
7. Quantum Mechanics-Aruldas, 2002
8. Quantum Mechanics-A.K. Ghatak and S. Loganathan-McMillan India 4<sup>th</sup> Edition, 1999
9. Quantum Mechanics-Messiah(North Holland)1970
10. Quantum Mechanics-L.I. Schiff- McGraw Hill 3<sup>rd</sup> Edition, 1968
11. Principles of Quantum Mechanics-R.Shankar, Springer, 2005

#### Tutorial: Quantum Mechanics II (This portion is not intended for examination purpose)

- 1) Difference in collision process between Classical and Quantum identical particles.
- 2) Optical theorem.
- 3) Partial wave analysis of scattering from standard simple potential; scattering cross-section.

## SECOND SEMESTER

### PAPER VI – ELECTROMAGNETIC THEORY

#### Unit I: Electrostatics

Coulomb's law- Gauss law-differential and integral representation- Electric field- Electric potential-energy density-Method of images-Multipole expansions.

#### Unit II: Electrostatics in macroscopic media

Potential and Field due to an Electric Dipole-Dielectric Polarization-External Field of a Dielectric Medium-Gauss' Theorem in a Dielectric-Electric Displacement Vector  $\mathbf{D}$ -Linear Dielectrics-Relations connecting Electric Susceptibility  $\chi_e$ , Polarization  $\mathbf{P}$ , Displacement  $\mathbf{D}$  and Dielectric Constant-Boundary Conditions of Field Vectors-Molecular Field-Clausius Mosotti Relation for Non-Polar Molecules- Electrostatic Energy and Energy Density

#### Unit III: Magnetostatics

Biot-Savart Law- Statement-Lorentz Force Law and Definition of B-Divergence and Curl of B Magnetic Scalar Potential (derivation of expression only)-Equivalence of Small Current Loop and Magnetic Dipole-Magnetic Vector Potential (derivation of expression only).

#### Unit IV: Electromagnetics

Equation of Continuity-Displacement Current-Derivation of Maxwell's Equations-Physical Significance-Poynting Vector-Momentum in EM Field-Electro Magnetic Potentials-Maxwell's Equations in terms of EM Potentials-Lorentz Gauge-Coulomb Gauge- Boundary Conditions at Interfaces-Reflection and Refraction-Fresnel's Laws-Brewster's Law & Degree of Polarization-Total Internal Reflection and Critical Angle.

#### Unit V: Relativistic Electrodynamics

Four Vectors-Transformation Relation for Charge and Current Densities for Electromagnetic Potentials- Covariant Form of Inhomogeneous Wave Equations-Covariance of Field Equations in terms of Four Vectors-Covariant Form of Electric and Magnetic Field Equations-Covariance of Electromagnetic Field Tensor-Covariant Form of Lorentz Force Law.

#### Books for Study & Reference

1. Electromagnetic Theory-Chopra & Agarwal-Nath & Co. 1984
2. Electrodynamics-Gupta, Kumar & Singh-Pragati Prakashan-Meerut 1600
3. Electromagnetic Theory & Electrodynamics-Satyaprakash-Kedarnath Ramnath & Co.- Meerut
4. Classical Electrodynamics-J.D. Jackson-Wiley Eastern 3<sup>rd</sup> Edition, 2004
5. Principles of Electrodynamics-M. Schwartz-McGraw Hill
6. Introduction to EM Fields & Waves-Carson & Lorrain

## **SECOND SEMESTER**

### **PAPER VII- ELECTRONIC DEVICES**

#### **Unit I: Semiconductor Devices**

FET as a Voltage Variable Resistor-Common Source Amplifier at High Frequencies-Common Drain Amplifier at High Frequencies-Silicon Controlled Rectifier (SCR)-Characteristics-SCR Power Control- Tunnel Diode Optoelectronics: Photo Resistor-Photo Diode-Photo Transistor-LED-Photo Voltaic Effect-Solar Cells

#### **Unit II: Operational Amplifier**

Frequency Response of an Op-Amp-Parameters of an Op-Amp-Sign Changer-Scale Changer-Adder- Subtractor-Phase Shifter-Differential Amplifier-Integrator- Differentiator-Analog Computer Setup to Solve Linear Simultaneous Equation-Differential Equations in Physics-Logarithmic & Exponential Amplifiers-Active Filters.

#### **Unit III: Digital Circuits & Devices I**

Logic Families-Combinational Logic-Function of Combinational Logic-Flip Flops and other Multivibrators-Counters

#### **Unit IV: Digital Circuits & Devices II**

Shift Registers-Memories RAM, ROM, PROM, EPROM-Charge Coupled Devices (CCD)

#### **Unit V: Signal Processing & Data Acquisition**

Wave Form Generators and Wave Shaping Circuits-Sinusoidal Oscillators-Phase Shift Oscillator-Wein Bridge Oscillator-Crystal Oscillator Multivibrators Comparators-Schmitt Trigger-Square Wave & Triangular Wave Generators-Pulse Generators-IC 555 Timer and its Application-Signal and Signal Processing-Analog Multiplexer and Demultiplexer- D/A Converters-A/D Converters.

#### **Books for Study & Reference:**

1. Microelectronics-Millman & Grabel-McGraw Hill, 1982
2. Integrated Electronics-Millman & Halkias-Tata McGraw Hill 17<sup>th</sup> Reprint 2000
3. Digital Fundamentals-Floyd-UBS 1600
4. Digital Principles and Applications-Malvino- McGraw Hill 1600
5. Physics of Semiconductor Devices-Wiley Eastern

**PRACTICAL I - GENERAL PHYSICS**  
**(Examination at the end of Second Semester)**

**Any Twelve Experiments**

1. Young's Modulus-Elliptical Fringes (Cornu's Method)
2. Young's Modulus-Hyperbolic Fringes (Cornu's Method)
3. Viscosity of a Liquid-Mayer's Oscillating Disc
4. Stefan's Constant
5. Rydberg's Constant-Solar Spectrum
6. Thickness of Wire by Air Wedge and Diffraction
7. Determination of Audio Frequencies-Bridge Method
8. Thermionic Work Function
9. Thermal Conductivity-Forbe's Method
10. Electronic Charge 'e' by Millikan's Oil Drop Method
11. Electronic Specific Charge 'e/m' by Thomson's Method
12. Thermistor-Temperature Coefficient and Band Gap Energy Determination
13. Specific Heat of a Liquid-Ferguson's Method
14. Biprism on Optical Bench-Determination of Wavelength
15. He-Ne Laser –Measurement of Wavelength using reflectance grating.
16. Babinet's Compensator
17. LG Plate-Resolving Power
18. Diffraction at a Prism Table-Determination of Wavelength
19. Fabry-Perot Interferometer-Study of Fine Structure
20. Geiger Muller Counter-Determination of Half Life of 'In'
21. Matlab Programming-Roots of a Quadratic Equation & Solution of a System of Linear Equations
22. Matlab Programming -Solution of Ordinary Differential Equations
23. Matlab Programming -Runge-Kutta Method
24. Matlab Programming -Newton-Raphson Method
25. Matlab Programming-Mean, Median & Standard Deviation
26. Matlab Programming-Curve Fitting & Interpolation
27. Matlab Programming-Matrix Summation, Subtraction and Multiplication
28. Matlab Programming-Matrix Inversion and Solution of Simultaneous Equations
29. He-Ne Laser – Measurement of refractive index of liquids.
30. He-Ne Laser – Power distribution measurement.
31. He-Ne Laser- Thickness of wire.

## **PRACTICAL II-ELECTRONICS**

(Examination at the end of Second Semester)

Any Fifteen Experiments

1. Design of Regulated and Dual Power Supply and Construction using fixed voltage regulator and  
723.
2. Basic Logic Gates-Digital IC's
3. Parameters of Op-Amp
4. Design of Wave Form Generators- using Op-Amp and Timer 555.
5. Design of Phase-Shift Oscillator- Op-Amp
6. Design of Wein's Bridge Oscillator- Op-Amp
7. Design of Active Filters- Op-Amp
8. Design of Differential Amplifier- Op-Amp
9. Sign Changer, Scale Changer, Summer and Subtractor- Op-Amp
10. Analog Computer Setup-Solving Simultaneous Equations
11. Design of UJT Relaxation Oscillator
12. CRO-Differentiating, Integrating, Clipping and Clamping Circuits, Square Wave Testing
13. Source Follower
14. SCR-Characteristics and an Application
15. A.C. Amplifier-Inverting, Non-Inverting, Voltage Follower- Op-Amp
16. Function generator using IC 8038
17. Measurement of Hall Coefficient of given Semiconductor-Estimation of Charge Carrier Concentration
18. Digital IC's- Counters, shift register(7476)
19. Schmitt Trigger using discrete components and OP-AMP/ Timer 555
20. Matlab Programming-Charging of a Capacitor in an RC Circuit with three Time Constants
21. Matlab Programming- Full Wave Rectifier-Determination of (a) Peak-to-Peak Value of Ripple Voltage, (b) DC Output Voltage (c) Discharge Time of the Capacitor (d) Period of Ripple Voltage
22. Matlab Programming- Plot of Voltage and Current of an RLC Circuit Under Steady State Conditions
23. Matlab Programming- NPN Transistor-Plotting Input & Output Characteristics
24. Matlab Programming-Frequency Response of a Low Pass Op-Amp Filter Circuit
25. Matlab Programming-Diode-Plot of Forward Characteristics & Load Line Plot-Estimation of Operating Point

## **THIRD SEMESTER**

### **PAPER VIII-EXPERIMENTAL TECHNIQUES & DATA ANALYSIS**

#### **UNIT – I**

Introduction Measurement of errors: accuracy, precision, resolution , sensitivity – absolute and relative errors. types of errors – gross error, systematic error and random error. standards of measurements – classification of standards, time and frequency standards, electrical standards, standards of temperature and luminous intensity.

**UNIT – II** Electrical transducer classification: Active and Passive transducers-resistive, inductive, capacitive, thermocouple and Piezoelectric transducers. Digital transducers.

**UNIT – III** Amplifiers and Signal Conditioning: Instrumentation amplifiers- Isolation amplifiers- Chopper amplifiers- Voltage to frequency and frequency to voltage converters- Frequency multipliers- logarithmic amplifiers, S/H Circuits Active filters-Low pass, High pass, Band pass and Band stop filters – Butterworth filters- All Pass filters. Phase sensitive detectors (PSD)- Phase lock loop (PLL) – Lock-in-amplifier.

**UNIT-IV** Signal Analysis: Wave Analyzers-Audio frequency Wave analyzer- Heterodyne wave analyzer- Harmonic distortion analyzers-Resonant harmonic distortion analyzer- Heterodyne harmonic distortion analyzer- Fundamental suppression harmonic distortion analyzer- Spectrum analyzer- Spectra of CW, AM, FM and PM waves.

**UNIT – V** Electronic Measuring Instruments: Q-meter- Vector impedance meter- Digital frequency meter – Digital voltmeter – Phase meter- RF power and voltage measurement – Power factor meter – Vector voltmeter. Display and Recording: X-t, X-Y Recorders- Magnetic Tape recorders- Storage Oscilloscope. Characteristics of digital displays: LED- LCD – Dot matrix and Seven Segment display systems.

#### Recommended Text Books:

1. Modern Electronic Instrumentation and Measurement Techniques – A.O. Hefnick and W.D. Cooper., Prentice Hall India Publications.
2. Instrumentation Devices and Systems – C.S. Rangan, G.R. Sharma and VSV Mani, Tata McGraw Hill Publications.
3. Introduction to Instrumentation and Control – A.K. Ghosh - Prentice Hall India Publications
4. Electrical & Electronics Measurement & Instrumentation - A.K. Sawhney
5. Modern electronic instrumentation – w.d. cooper

## THIRD SEMESTER

### PAPER IX- NUCLEAR & PARTICLE PHYSICS

#### Unit I: Nuclear Structure

Distribution of Nuclear Charge-Nuclear Mass-Mass Spectroscopy-Mass Spectrometer-Theories of Nuclear Composition (proton-electron, proton-neutron)- Bound States of Two Nucleons-Spin States- Pauli's Exclusion Principle-Tensor Force-Static Force-Exchange Force.

#### Unit II: Radioactivity

**Alpha Decay:** Properties of  $\alpha$  Particles-Gamow's Theory of  $\alpha$  Decay-Geiger Nuttal Law-  $\alpha$  Ray Energies-Fine Structure of  $\alpha$  Rays-  $\alpha$  Disintegration Energy-Long Range  $\alpha$  Particles.

**Beta Decay:** Properties of  $\beta$  Particles-General Features of  $\beta$  Ray Spectrum-Pauli's Hypothesis-Fermi's Theory of  $\beta$  Decay-Forms of Interactions and Selection Rules.

**Gamma Decay:** Absorption of  $\gamma$  Rays by Matter-Interaction of  $\gamma$  Rays with Matter-Measurement of  $\gamma$  Ray Energies-Internal Conversion.

#### Unit III: Nuclear Models

**Liquid Drop Model:** Bohr Wheeler Theory of Fission-Condition for Spontaneous Fission-Activation Energy-Seaborg's Expression.

**Shell Model:** Explanation of Magic Numbers-Prediction of Shell Model-Prediction of Nuclear Spin and Parity-Nuclear Statistics-Magnetic Moment of Nuclei-Schmidt Lines-Nuclear Isomerism.

**Collective Model:** Explanation of Quadrupole Moments.

#### Unit IV: Nuclear Reactions

Kinds of Reactions and Conservation Laws-Energy of Nuclear Reaction-Iso Spin-Continuum Theory of Nuclear Reaction-Resonance-Breit and Wigner Dispersion Formula-Stages of a Nuclear Reaction- Statistical Theory of Nuclear Reaction-Kinematics of Stripping and Pickup Reaction.

#### Unit V: Particle Physics

Leptons-Hadrons-Mesons-Hyperons-Pions-Meson Resonances-Strange Mesons and Baryons-Gell-Mann Okuba Mass formula for Baryons-CP Violation in Neutral Kaons ( $K_0$ ) Decay-Symmetry and Conservation Laws-Quark Model-Reaction and Decays.

#### Books for Study & Reference:

1. Concepts of Nuclear Physics-Bernard L. Cohen-Tata McGraw Hill- New Delhi 1600,1978
2. Introductory Nuclear Physics-Kenneth S. Krane-John Wiley & Sons
3. Nuclear Physics- D.C. Sharma-K.Nath & Co-Meerut 1600
4. Nuclear and Particle Physics-Pandya and Yadav
5. Nuclear Physics-J.C. Tayal-Umesh Prakashan-Gujarat
6. Physics of Nucleus and Particles-Volume I & II-B. Nermeir & Sheldon
7. The Investigations of Physics World-G.Torld di Froncia-Cambridge University Press
8. Auto Nuclear-Evan-McGraw Hill

## THIRD SEMESTER

### PAPER X-SPECTROSCOPY

#### Unit I: Atomic & Microwave Spectroscopy

Spectra of Alkali Metal Vapours-Normal Zeeman Effect-Anomalous Zeeman Effect-Magnetic Moment of Atom and the G Factor-Lande's 'g' Formula-Paschen Back Effect-Hyperfine Structure of Spectral Lines. Microwave Spectroscopy-Experimental Method-Theory of Microwave Spectra of Linear, Symmetric Top Molecules-Hyperfine Structure-Quadrupole Moment-Inversion Spectrum of Ammonia.

#### Unit II: Infrared & Raman Spectroscopy

**IR Spectroscopy:** Practical Aspects-Theory of IR Rotation Vibration Spectra of Gaseous Diatomic Molecules-Applications-Basic Principles of FTIR Spectroscopy.

**Raman Spectroscopy:** Classical and Quantum Theory of Raman Effect-Rotation Vibration Raman Spectra of Diatomic and Polyatomic Molecules-Applications-Laser Raman Spectroscopy.

#### Unit III: Electronic Spectra: Fluorescence & Phosphorescence Spectroscopy

Electronic Excitation of Diatomic Species-Vibrational Analysis of Band Systems of Diatomic Molecules-Deslandre's Table-Intensity Distribution-Franck Condon Principle-Rotational Structure of Electronic Bands-Resonance and Normal Fluorescence-Intensities of Transitions-Phosphorescence Population of Triplet State and Intensity-Experimental Methods-Applications of Fluorescence and Phosphorescence.

#### Unit IV: NMR & NQR Spectroscopy

**NMR Spectroscopy:** Quantum Mechanical and Classical Description-Bloch Equation-Relaxation Processes-Experimental Technique-Principle and Working of High Resolution NMR Spectrometer- Chemical Shift

**NQR Spectroscopy:** Fundamental Requirements-General Principle-Experimental Detection of NQR Frequencies-Interpretation and Chemical Explanation of NQR Spectroscopy

#### Unit V: ESR & Mossabauer Spectroscopy

**ESR Spectroscopy:** Basic Principles-Experiments-ESR Spectrometer-Reflection Cavity and Microwave Bridge-ESR Spectrum-Hyperfine Structure

**Mossabauer Spectroscopy:** Mossabauer Effect-Recoilless Emission and Absorption-Mossabauer Spectrum-Experimental Methods-Hyperfine Interaction-Chemical Isomer Shift-Magnetic Hyperfine and Electric Quadrupole Interaction

#### Books for Study & Reference:

1. Molecular Structure and Spectroscopy – G. Aruldhas
2. Spectroscopy: Volumes I, II and III-B.P. Straugham & S. Walker
3. Fundamental of molecular spectroscopy – C.B.Banwell
4. Introduction to molecular spectroscopy - G.M.Barrow.
5. Atomic Physics - J.B.Rajam, S.Chand Publications.

## **FOURTH SEMESTER**

### **PAPER XI- COMMUNICATION ELECTRONICS**

#### **Unit I: Antennas & Wave Propagation**

Terms and Definition-Effect of Ground on Antennas-Grounded  $\lambda/4$  Antenna-Ungrounded  $\lambda/2$  Antenna- Antenna Arrays-Broadside and End Side Arrays-Antenna Gain-Directional High Frequency Antennas- Sky Wave Propagation-Ionosphere-Ecles & Larmor Theory-Magneto Ionic Theory-Ground Wave Propagation.

#### **Unit II: Microwaves**

Microwave Generation-Multicavity Klystron-Reflex Klystron-Magnetron-Travelling Wave Tubes (TWT) and other Microwave Tubes-MASER-Gunn Diode.

#### **Unit III: Radar and Television**

Elements of a Radar System-Radar Equation-Radar Performance Factors-Radar Transmitting Systems- Radar Antennas-Duplexers-Radar Receivers and Indicators-Pulsed Systems-Other Radar Systems- Colour TV Transmission and Reception.

#### **Unit III: Communication Electronics**

Analog and Digital Signals – Modulation – Types of Modulation- Amplitude modulation theory – Frequency spectrum of the AM wave – Representation of AM – Power relations in the AM wave – Generation of AM – Basic requirements- Description of frequency and phase modulation – Mathematical representation of FM – Frequency spectrum of the FM wave - Effects of noise on carrier.

#### **Unit V: Optical Fibres**

Propagation of Light in an Optical Fibre-Acceptance Angle-Numerical Aperture-Step and Graded Index Fibres-Optical Fibre as a Cylindrical Wave Guide-Wave Guide Equations-Wave Equations in Step Index Fibres-Fibre Losses and Dispersion-Applications.

#### **Books for Study & Reference:**

1. Electronic Communication System-George Kennedy & Davis -Tata McGraw Hill 4<sup>th</sup> edition 19889
2. Principles of Communication Systems-Taub Schilling-TMH 1986
3. Communication Systems-Simon Haykin-John Wiley & Sons 2005
4. Electronics & Radio Engineering-F.E.Terman- McGraw Hill
5. Communication Systems-Carlson- McGraw Hill 3<sup>rd</sup> Edtion 1986
6. Fibre Optics technology & Applications-Stewart D. Personick-Khanna Publishers-Delhi

## FOURTH SEMESTER

### PAPER XII-CONDENSED MATTER PHYSICS

#### Unit I: Crystal Structure & Diffraction

Lattice Constant and Density-Reciprocal Lattice Concept-Graphical Construction-Vector Development of Reciprocal Lattice-Properties-Reciprocal Lattice to BCC, FCC Lattices-Bragg Condition in terms of Reciprocal Lattice-Rotary Crystal Method of X-Ray Diffraction-Neutron Diffraction-Principle- Advantage-Experiment

#### Unit II: Crystal Defects & Dislocations

**Defects:** Classification-Point Defects-Schottky Defect-Frenkel Defect-Colour Centers-F Centre-Other Colour Centers-Production of Colour Centers by X-Rays and Irradiation.

**Dislocations:** Slip and Plastic Deformation-Shear Strength of Single Crystals-Edge Dislocation-Screw Dislocation-Stress Field around an Edge Dislocation

#### Unit III: Lattice Vibrations, Semiconductors & Dielectrics

Vibrations of One Dimensional Diatomic Linear Lattice-Acoustic and Optical Branches-Phonon State- Semiconductors-Conductivity of Semiconductors-Model for Intrinsic and Impurity Semiconductors-Hall Effect-Dielectrics-Ferro Electric Crystals-Ferro Electric Domains

#### Unit IV: Metals & Superconductors

Heat Capacity of Electron Gas-Experimental Electrical Resistivity of Metals-Superconductivity-Electron Phonon Interaction-Cooper Pairs-BCS Theory-Energy Gap and its Temperature Dependence-London Equation-Josephson Effect & Applications-High Temperature Superconductivity.

#### Unit V: Magnetism

Langevin Theory of Paramagnetism-Quantum Theory of Paramagnetism-Curie Law-Ferromagnetism-Weiss Molecular Field Theory-Domain Theory-Anti Ferromagnetism-Neel Theory-Ferrimagnetism-Ferrites-Spin Waves-Experimental Techniques to Study Magnetic Properties.

#### Books for Study & Reference:

1. Introduction to Solid State Physics-C. Kittel-Wiley Eastern-New Delhi 7<sup>th</sup> Edition 2000
2. Solid State Physics-B.S. Saxena, R.C. Gupta & P.N. Saxena-Pragati Prakashan- Meerut 8<sup>th</sup> edition 2001
3. Solid State Physics-A.J. Dekker-Macmillan India 1995
4. Solid State Physics-S.L. Kahani & C. Hemaranjani-Sultan Chand & Sons
5. Solid State Physics-H.E. Hall-John Wiley & Sons
6. An Introduction to Solid State Physics & Its Applications-R.J. Elliot & A.P. Gibson-ELBS & Macmillan
7. Principles of Solid State-H.V. Keer-Wiley Eastern
8. Physics of Solids-C.A. Wert & R.M. Thomson-McGraw Hill 1600
9. Fundamentals of Solid State Physics-J.R. Christmann- John Wiley & Sons 1600

## FOURTH SEMESTER

### PAPER XIII - THERMODYNAMICS AND STATISTICAL PHYSICS

#### UNIT I: Thermodynamics and Radiation:

Second law of thermodynamics- Entropy and Second law of thermodynamics- Entropy and disorder- Thermodynamic Potential and reciprocity relation- Thermodynamics equilibria- Chemical Potential- Blackbody radiation- Planck's radiation law.

#### UNIT II: Basic Concepts:

Phase space- Volume in phase space-Number of phase cells in given energy range of harmonic oscillator- Number of phase cell in the given energy range of 3-dimensional free particle- Concept of ensemble- Micro canonical ensemble-Canonical ensemble- Grand Canonical ensemble- Density distribution in phase space- Liouville's theorem- Postulate of equal A priori probability- Statistical equilibrium- Thermal equilibrium- Mechanical equilibrium-Particle equilibrium-Connection between Statistical and thermodynamic quantities.

#### UNIT III: Classical Distribution Law:

Microstates and Macro states-Classical Maxwell-Boltzmann distribution law- Evaluation of constants,  $\alpha$  and  $\beta$ - Maxwell's law of Distribution of velocities- Principle of equipartition energy- Gibbs paradox- Partition function and its correlation with thermodynamics quantities- Partition functions and its properties- Comparison of ensembles- Equipartition theorem- Applications

#### UNIT IV: Quantum Statistics:

Indistinguishability and quantum statistics- Statistical weight and a priori probability- Identical particles and symmetry requirements- Bose Einstein's Statistics- Fermi Dirac Statistics- Results of three statistics- Thermodynamic interpretation of parameter's  $\alpha$  and  $\beta$ - Blackbody radiation and Planck radiation- Specific heat of solid; Dulong and Petit's law- Einstein's Theory- Debye theory.

#### UNIT V: Application of Quantum Statistics:

Energy and pressure of ideal Bose Einstein gas- Bose Einstein condensation- Liquid helium- Energy and pressure of ideal Fermi Dirac gas- Free electron model and electronic emission- White Dwarfs- Onsager relations- Fluctuation; Energy, Pressure, Enthalpy- Bragg-Williams Approximation- One dimensional Ising model

#### Books for Study & Reference:

1. STATISTICAL MECHANICS, **Gupta & Kumar**, 20<sup>th</sup> edition, Pragati Prakashan Meerut, Begam Bridge Meerut, 2003.
2. FUNDAMENTALS OF STATISTICAL MECHANICS, **Keiser Huang**, Revised edition

## **FOURTH SEMESTER**

### **PAPER XIV - PLASMA PHYSICS**

#### **Unit – I Fundamental concepts about Plasma**

Kinetic pressure in a partially ionized – mean free path and collision cross section- mobility of charged particles – Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity- Effect of magnetic field; Dielectric constant of plasma- Quasi-neutrality of plasma Debye shielding distance – Optical properties of plasma.

#### **Unit – II Motion of charged particles in Electric and Magnetic field:**

Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and magnetic fields- Motion of charged particle in inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement – motion of an electron in a time varying electric field- Magneto-hydrodynamics - Magneto-hydrodynamic equations – Interpretations of equations – Condition for magnetohydrodynamic behavior.

#### **Unit – III Plasma oscillations and waves**

Introduction, theory of simple oscillations - electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation – Ion oscillation and waves in a magnetic field – thermal effects on plasma oscillations – Landau damping – Hydromagnetic waves – Magnetosonic waves – Oscillations in an electron beam.

#### **Unit – IV Plasma Diagnostics techniques**

Single probe method - Double probe method – Use of probe technique for measurement of plasma parameters in magnetic field – microwave method – spectroscopic method - -laser as a tool for plasma diagnostics-X-ray diagnostics of plasma – acoustic method – conclusion.

#### **Unit-V Possible applications of plasma physics**

Magnetohydrodynamic generator – Basic theory – Principle of working – the fuel in M.H.D.-generator – generation of microwaves utilizing high density plasma – Plasma diode.

#### **Books for study and reference:**

1. Plasma physics- plasma state of matter – S.N.Sen, Pragati Prakashan, Meerut
2. Introduction to plasma physics – F.F.Chen, Plenum press, London
3. Principles of plasma physics – Krall & Trivelpiece
4. Introduction to Plasma Theory-D.R. Nicholson
5. The Plasma State-J.L. Shohet
6. Introduction to Plasma Physics-M. Uman
7. Principles of Plasma Diagnostics-I.H. Hutchinson
8. Plasma Diagnostic Techniques-R.H. Huddlestone & S.L. Leonard

**PRACTICAL III- ADVANCED PRACTICALS**  
(Examination at the end of Fourth Semester)

Any Twelve Experiments

1. AIO Band
2. CN Band
3. Arc Spectra-Constant Deviation Spectrograph-Copper, Iron & Barium
4. Michelson Interferometer-  $\lambda$ ,  $d\lambda$  and Thickness of Mica Sheet
5. Susceptibility-Guoy and Quincke's Method
6. Compressibility of a Liquid-Ultrasonic Method
7. Hall Effect and its application
8.  $e/m$ -Zeeman Effect
9.  $e/m$ -Magnetron Method
10. B-H Curve-Anchor Ring
11. B-H Curve-Solenoid
12. Double Slit-Wavelength Determination
13. G.M Counter-Characteristics
14. Kelvin's Double Bridge-Determination of Very Low Resistance & Temperature Coefficient of Resistance.
15. He-Ne Laser
16. Conductance of photoconductor, photovoltaic cell(solar cell)and photodiode.
17. Study of Fluorescent Spectrum of DCN Dye and Determination of Quantum Yield of Fluorescence Maxima and Full Width Maxima using Monochromator.
18. Matlab Programming-Radioactive Decay
19. Matlab Programming-Numerical Integration
20. Matlab Programming-Double Integration
21. Matlab Programming-Solution of Ordinary Differential Equations
22. Matlab Programming-Computer Simulation of Equations of Motion for a System of Particles
23. Matlab Programming-Computer Simulation of 1-D and 2-D Lattice Vibrations
24. Matlab Programming-Computer Simulation of Kronig-Penney Model
25. Matlab Programming-Numerical simulation of Wave-Functions of Simple Harmonic Oscillator
26. Matlab Programming-Simulation of Wave Functions for a Particle in Critical Box
27. Matlab Programming-Solution of Diffusion Equation

## **PRACTICAL IV-SPECIAL ELECTRONICS**

(Examination at the end of Fourth Semester)

Any Ten Experiments

1. Op-Amp: Simultaneous Addition & Subtraction
2. Op-Amp: Instrumentation Amplifier-Temperature Measurement
3. Op-Amp: Instrumentation Amplifier-Light Intensity-Inverse Square Law
4. Op-Amp: V to I & I to V Converter
5. Op-Amp: Circuits Using Diodes-Half Wave, Full Wave, Peak Value, Clipper, Clamper
6. Op-Amp: Log and Antilog Amplifier
7. Op-Amp: Analog Computation-Second Order Differential Equation
8. Op-Amp Comparator-Zero Crossing Detector, Window Detector, Time Marker
9. IC 555 Timer Application-Monostable, Linear & Astable
10. A/D Converters-Any One Method
11. D/A Converters-Binary Weighted & Ladder Methods
12. IC Counters with Feedback
13. Microprocessor: LED Interfacing
14. Microprocessor: Stepper Motor Interfacing
15. Microprocessor: Traffic Control Simulation
16. Microprocessor: ADC Interface-Wave Form Generation
17. Microprocessor: Hex Keyboard Interfacing
18. Microprocessor: Musical Tone Generator Interface
19. Microcontroller : Blinking of LEDs either 8051 or 16F84
20. Microcontroller: Controlling LED with switch.
21. Microcontroller: DC motor control.
22. Microcontroller : triangle wave generator.

## **GROUP A - PAPER I - FUNDAMENTALS OF NANOSCALE SCIENCE**

### **Unit I: Basics of Nanotechnology I**

Background to Nanotechnology – scientific revolutions – types of nanotechnology and nanomachines – atomic structure molecules & phases – molecular and atomic size – surfaces and dimensional space – top down and bottom up Nanoscale formation

### **Unit II: Forces between atoms and molecules**

Strong intermolecular forces – covalent and coulomb interactions – interactions involving polar molecules and polarization – weak intermolecular forces and total intermolecular pair potentials – Van der Waals forces – repulsive forces; special interactions such as hydrogen – bonding, hydrophobic and hydrophilic interactions

### **Unit III: Nanostructures and their properties**

Definition of nano systems – dimensionality and size dependent phenomena in Quantum dots, and Quantum wires – size dependent variation in magnetic, electronic transport properties

### **Unit IV: High vacuum technology**

Evaporation theory – different sources for evaporation – working principles of rotary and diffusion pumps – cryogenic pumps – cryo sorption and getter pumps – vacuum materials

### **References:**

1. Nanotechnology: basic science and emerging technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005)
2. Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,) (2000)
3. Understanding Nanotechnology, Scientific American, editors at Scientific American, Warner Books (2002)
4. Introduction to Nanotechnology, Charles P. Poole, Frank J. Owens, Wiley-Interscience (2003)
5. Nanotechnology: A Gentle introduction to the Next Big Idea, Mark A. Ratner, Daniel Ratner, Mark Ratne, Prentice Hall PTR; 1<sup>st</sup> edition (2002)
6. Fundamentals of Surface and Thin Film Analysis, Leonard C.Feldman and James W. Mayer
7. Hand book of thin film technology, L.I. Maissel and R. Glang (McGraw – Hill Book Company)

## **GROUP A - PAPER II - NANOMATERIALS SYNTHESIS**

### **Unit I: Sol-gel processing**

Fundamentals of sol-gel process – sol-gel synthetic methods for oxides – other inorganics and nano composites – the Pecheni method – silica gel – Zirconia and Yttrium gel – aluminosilicate gel – polymer nano composites

### **Unit II: Film deposition methods**

Introduction – fundamentals of film deposition – thermal evaporation – molecular beam epitaxy – pulsed laser deposition – sputter deposition – chemical vapour deposition – layer by layer growth and ultra thin films – chemical solution deposition – Langmuir Blodgett films.

### **Unit III: Synthesis of nanostructures**

Surface Chemistry and its role to prepare quantum dots – Polymer as quantum dot size stabilizer – One-dimensional (1D) by Spontaneous Growth – 1D structure by VLS and SLS Growth – Template Assisted Growth – Electrochemical growth of 1D structures

### **Unit IV: New forms of carbon**

Types of nanotubes – formation of nanotubes – methods and reactants – arcing in the presence of cobalt – laser methods – ball milling – chemical vapour deposition methods – properties of nano tubes – plasma arcing – electro deposition – pyrolytic synthesis – Zeolites and templated powders layered silicates.

### **References:**

1. Nanoelectronics and Information technology: Advanced electronic materials and novel devices (2<sup>nd</sup> edition), Rainer Waser (Ed.), Wiley – VCH Verlag, Weiheim (2005)
2. Nanocomposite science and technology, Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley – VCH Verlag, Weiheim (2003)
3. Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,) (2000)
4. Quantum Heterostructures: Microelectronics and Optoelectronics, Vladimir Mitin
5. Theory of Modern electronic semiconductor devices, K.F. Brennan and A.S. Brown
6. Semiconductor Nanostructures for Optoelectronic applications, Todd D. Steiner
7. Smart Electronic Materials (Fundamentals and applications), Jasprit Singh
8. The Physics of Low dimensional semiconductors, John H. Davies

## **GROUP A - PAPER III - CHARACTERIZATION AND APPLICATION OF NANO MATERIALS**

### **Unit I: Nano characterizing tool 1**

Working of Atomic Force Microscopy – Mode of operations (qualitative) and its application – X-Ray diffraction basics and its application to Size Analysis of nanomaterials – NMR Basics and application to Nanomaterials

### **Unit II: Nano characterizing tool 2**

Scanning Electron Microscope: Theory- Instrumental setup and its application –Low KV SEM and its application – Low temperature SEM and its application – working of electron probe micro analysis and its application in elemental analysis – EDX spectra Important material systems – optical process in semiconductors – optical process in quantum wells – semiconducting optoelectronic devices – organic optoelectronic devices (qualitative)

### **Unit III: Applications of nanomaterials**

Quantum dot IR photo detectors- Quantum dot lasers – Synthesis of Zinc oxide nanomaterials and its application – Synthesis of group three nitride nanostructures and their applications - SK growth of germanium dots on silicon and its application.

### **Unit IV: Cell Biology (quantitatively)**

Amino acids, Protein structure: Primary, Secondary, tertiary, structure of Nucleic acids – Nucleosides and Nucleotides – physical properties of nucleosides & nucleotides –base pair – mismatch base pair – stacking – Backbone of Nucleic acids Antibodies and their use in nano based drug delivery and imaging – Tumor targeted drug delivery.

### **References:**

1. Nanoscale calibration and Standards and Methods Edited by C.Wilkening and Koenders
2. Fundamentals of Surface and Thin Film Analysis, Leonard C.Feldman and James W. Mayer
3. Scanning Electron Microscopy for Nanotechnology Edited by W.Zhou and Z. Lin Wang
4. Nanosystem characterization tools in the life sciences Edited by Challa Kumar
5. Nanostructures and Nanomaterials (Synthesis, Properties and Applications), Guozhong Cao
6. Nanoelectronics and Information technology Edited by Rainer Waser
7. Cell and Molecular Biology, Gerald Karp
8. Nucleic Acids in Chemistry and Biology, G. Michael Blackburn and Michal J. Gait
9. Principles of Nucleic Acid structure, Worfram Saenger

## **GROUP B - PAPER I - INTRODUCTORY ASTRONOMY AND ASTROPHYSICS**

### **Unit I:**

Introductory History Of Astronomy-Ptolemy's Geocentric Universe-Copernicus' Heliocentric Universe-Tycho Brahe's Observations-Galileo Galilee-Kepler's Laws Of Planetary Motion-Newtonian Concept Of Gravity-Highlights Of Einstein'S Special And General Theory Of Relativity-Curved Space-Time-Evidence Of Curved Space-Time-Bending Of Light-Time Dilation-Gravitational Redshift-Gravitational Waves

### **Unit II:**

Stars And Galaxies-Distances-Trigonometric Parallax-Inverse Square Law-Magnitude Of Stars-Apparent Magnitude-Absolute Magnitude And Luminosity-Color And Temperature-Composition Of Stars-Velocity, Mass And Sizes Of Stars-Types Of Stars- Temperature Dependence-Spectral Types-Hertzsprung-Russell (HR) Diagram-Spectroscopic Parallax

### **Unit III:**

The Sun-Its Size And Composition-Sun's Interior Zones-Core-Convective Zone- Radiative Zone-Sun's Surface-Photosphere-Chromosphere-Corona-Sun's Power Source-Fusion Reaction Mechanism-Neutrinos And The Solar Neutrino Problem-Interior Structure Of Stars-Origin Of Moon-Solar And Lunar Eclipses-Studies Of Lunar Surface From Various Space Missions And Their Results-Satellites Of Other Planets Of The Solar System

### **Unit IV:**

Stellar Evolution-Mass Dependence-Giant Molecular Cloud-Protostar-T Tauri-Main Sequence Star-Subgiant, Red Giant, Supergiant-Core Fusion-Red Giant Or Supergiant-Planetary Nebula Or Supernova- Core Remnant-Stellar Nucleo Synthesis-Stellar Remnants-Degenerate Matter-White Dwarfs-Novae And Supernovae- Neutron Stars-Pulsars-Black Holes-Detecting Black Holes

### **BOOKS FOR STUDY & REFERENCE:**

1. Lectures On Astronomy, Astrophysics, And Cosmology-Luis A. Anchordoqui-Lecture Notes Of Department Of Physics, University Of Wisconsin-Milwaukee
2. J.A.Ratcliffe: An Introduction To The Ionosphere And Magnetosphere.
3. Kaula. W.M.: An Intoduction To Planetary Physics.
4. Harold Zirin: Astrophysics Of The Sun.
5. W.N.Hess And G.Mead(Ed): Introduction To Space Science.
6. V.Bedmtay And Kleczek:Basic Mechanism Of Solar Activity.
7. Sagan C. Owen T. C. And Smith. H.J.: Planetary Atmospheres.
8. Kaufmann, W.J. : Exploration Of The Solar System.
9. Baugher, J.F.: The Space Age Solar System
10. K.D. Abhayankar: Astrophysics Of The Solar System.
11. www.Astronomynotes.Com

## **GROUP B - PAPER II - INTRODUCTORY COSMOLOGY**

### **Unit I:**

Introduction to cosmology-Basic Observations and implications-Olbers' Paradox and the Dark Night Sky-Expanding Universe-Gravitational Redshift-Doppler Effect-Hubble's Law - Cosmological Principle-The Perfect Cosmological Principle-Universe with Positive, Negative and No curvature

### **Unit II:**

Observation and interpretation of Cosmic Microwave Background Radiation (CMBR)-Matter to Energy to Matter Conversion-Cosmic Abundance of Helium and Hydrogen-Evidence Supporting the General Big Bang Theory-Salient features of Steady State Theory

### **Unit III:**

Fate of the Universe-Dependence on Mass (Curvature of Space)-Critical density-Open Universe-Closed Universe-Homogenous and Isotropic Friedmann-Robertson-Walker Universes- Observations on Dark Matter from Orbital speeds of stars in galaxies, Faint gas shells around ellipticals, Motion of galaxies in a cluster, Hot gas in clusters, Quasar spectra and Gravitational Lensing

### **Unit IV:**

Deriving the Geometry of the Universe from the Background Radiation-Flatness Problem-Horizon Problem-Inflation and its effect on the universe-The Cosmological Constant

### **BOOKS FOR STUDY & REFERENCE:**

1. Lectures On Astronomy, Astrophysics, And Cosmology-Luis A. Anchordoqui-Lecture Notes Of Department Of Physics, University Of Wisconsin-Milwaukee
2. J.A.Ratcliffe: An Introduction To The Ionosphere And Magnetosphere.
3. Kaula. W.M.: An Introduction To Planetary Physics.
4. Harold Zirin: Astrophysics Of The Sun.
5. W.N.Hess And G.Mead(Ed): Introduction To Space Science.
6. V.Bedmtay And Kleczek:Basic Mechanism Of Solar Activity.
7. Sagan C. Owen T. C. And Smith. H.J.: Planetary Atmospheres.
8. Kaufmann, W.J. : Exploration Of The Solar System.
9. Baugher, J.F.: The Space Age Solar System
10. K.D. Abhayankar: Astrophysics Of The Solar System.
11. www.Astronomynotes.Com

## **GROUP B – PAPER III - ASTRONOMICAL TECHNIQUES**

**Unit I:** Telescopes Types Of Telescopes-Design And Construction Of A Simple Optical Telescopes-Schmidt Telescopes-Sky Charts And Their Importance-Solar Telescopes.

**Unit II:** Detectors Detectors For Optical And Infrared Regions-Application Of CCD'S To Stellar Imaging, Photometry And Spectroscopy-Techniques Of Observations Of Astronomical Sources From Space In Infrared. EUV, X-Ray And Gamma-Ray Regions Of The Electromagnetic Spectrum

**Unit III:** Photometry And Spectroscopy

Astronomical Photometry-Simple Design Of An Astronomical Photometer-Observing Technique With A Photometer Correction For Atmospheric Extinction-Transformation To A Standard Photometric System-Astronomical Spectroscopy-Spectral Classification- Simple Design Of Astronomical Spectrograph-Radial Velocity Measurements.

**Unit IV:** Radio Astronomy Techniques Basic Parameters Of An Antenna-VariouS Types Of Antennas-Non-Steerable, Partially Steerable And Fully Steerable Radio Telescopes-Receiver Systems And Their Calibration. Two-Element And Multi-Element Interferometers-LB. And VLBI Systems- Aperture Synthesis.

### **Books for Study & Reference:**

1. C.R.Kitchin: Astrophysical Techniques.
2. Gordon Walker: Astronomical Observations - An Optical Perspective (Cambridge University Press).
3. Henden And Kaitchuck: Astronomical Photometry.
4. Astrophysics-Stars And Galaxies By K.D.Abhyankar.
5. C.R.Miczaika And W.M.Sinton: Tools Of The Astronomers
6. W.A.Hiltner (Ed): Astronomical Techniques.
7. Carleton: Methods Of Experimental Physics. Vol.XIIA.