CHOICE BASED CREDIT SYSTEM – STRUCTURE

FOR THOSE WHO HAVE JOINED IN THE ACADEMIC YEAR 2017–18 ONWARDS

M.Sc PHYSICS

Part	Subject	CODE	Hrs.	Cr.	Adl. Cr.	Exam (Hrs)	Marks	
							Int.	Ext.
Core	Mathematical Physics–I	172104101	6	5		3	25	75
Core	Classical and Statistical Mechanics	172104102	6	5		3	25	75
Core	Electromagnetic Theory	172104103	6	5		3	25	75
Core Lab	Non–Electronics Practical	–	3			–	–	–
Core Lab	Electronics Practical	–	3			–	–	–
Elective	Numerical Methods	172104104	6	5		3	25	75
SLC	In Plant Training *Report;@Viva	178004121	–	–	3	–	40 30+10	60 50+10
Core	Mathematical Physics–II	172104201	6	5		3	25	75
Core	Quantum mechanics – I	172104202	6	5		3	25	75
Core	Applied Electronics	172104203	6	5		3	25	75
Core Lab	Non–Electronics Practical	172104204	3	2		4	40	60
Core Lab	Electronics Practical	172104205	3	2		4	40	60
NME	Energy Physics	174604221	6	4		3	25	75
SLC	Object Oriented Programming With C++	178004221			3	3	–	100
Part – III Core	Solid State Physics – I	172104301	6	5		3	25	75
Core	Quantum Mechanics – II	172104302	6	5		3	25	75
Core	Nuclear Physics	172104303	6	5		3	25	75
Core Lab	Electronics Practical	–	3	-		–	–	–
Core Lab	Project	–	3	-		–	–	–
Elective	Microprocessor	172104304	6	5		3	25	75
SLC	Bio–Physics	178004321	–	–	3	3	–	100
Core	Solid State Physics – II	172104401	6	5		3	25	75
Core	Applied Optics and non linear Dynamics	172104402	6	5		3	25	75
Core	Molecular Spectroscopy	172104403	6	5		3	25	75
Core Lab	Advanced Physics Experiment	172104404	3	3		4	40	60
Elective	Nano Science	172104405	6	5		3	25	75
Elective	Project *Report;@Viva	172104406	3	4		–	40 [24:16]	60 [36:24]
SLC	Information Technology	178004421			3	3	–	100
		TOTAL	**120**	**90**	**12**			

M.Sc Physics: Those Who Have Joined In The Academic Year 2017–18 Onwards Under CBCS System

Core Subject **SOLID STATE PHYSICS – I** **Code: 172104301**

SEMESTER III

6 Hrs/Week
Credits 5

Objectives:

- ***To learn about the different crystal structures and their properties.***
- ***To understand the classification of solids based on their energy band gaps***

UNIT – I: **[18 Hrs]**

Crystal Structure: Periodic Arrays of Atoms - Lattice Translation Vectors - Basis and the Crystal Structure - Primitive Lattice Cell - Fundamental Types of Lattices - Two-Dimensional Lattice Types - Three-Dimensional Lattice Types - Index System for Crystal Planes - Simple Crystal Structures - Sodium Chloride Structure - Cesium Chloride Structure - Hexagonal Close Packed Structure (hcp) - Diamond Structure - Cubic Zinc Sulfide Structure.

Wave Diffraction and the Reciprocal Lattice: Diffraction of Waves by Crystals - The Bragg Law – Scattered Wave Amplitude – Fourier Analysis – Reciprocal Lattice Vectors – Diffraction Conditions – Laue Equations – Brillouin Zones – Reciprocal Lattice to sc Lattice - Reciprocal Lattice to bcc Lattice - Reciprocal Lattice to fcc Lattice – Fourier Analysis of the Basis – Structure Factor of the bcc Lattice – Structure Factor of the fcc Lattice – Atomic Form Factor.

UNIT – II: **[18 Hrs]**

Crystal Binding and Elastic Constants: Crystals of Inert Gases - Van der Waals - London Interaction - Repulsive Interaction - Equilibrium Lattice Constants - Cohesive Energy - Ionic Crystals - Electrostatic or Madelung Energy - Evaluation of the Madelung Constant - Covalent Crystals – Metals - Hydrogen Bonds - Analysis of Elastic Strains – Dilation - Stress Components - Elastic Compliance and Stiffness Constants - Elastic Energy Density - Elastic Stiffness Constants of Cubic Crystals - Bulk Modulus and Compressibility - Elastic Waves in Cubic Crystals - Waves in the [100] Direction - Waves in the [110] Direction.

UNIT – III: **[18 Hrs]**

Phonons I. Crystal Vibrations: Vibrations of Crystals with Monatomic Basis - First Brillouin Zone - Group Velocity - Long Wavelength limit - Derivation of Force Constants from Experiment -

Two Atoms per Primitive Basis - Quantization of Elastic Waves - Phonon Momentum.

Phonons II. Thermal Properties: Phonon Heat Capacity - Planck Distribution - Normal Mode Enumeration - Density of States in One Dimension - Density of States in Three Dimensions - Debye Model for Density of States - Debye T^3 Law - Einstein Model of the Density of States - Anharmonic Crystal Interactions - Thermal Expansion - Thermal Conductivity - Thermal Resistivity of Phonon Gas - Umklapp Processes.

UNIT – IV: **[18 Hrs]**

Free Electron Fermi Gas: Energy Levels in One Dimension - Effect of Temperature on the Fermi-Dirac Distribution - Free Electron Gas in Three Dimensions - Heat Capacity of the Electron Gas - Experimental Heat Capacity of Metals - Electrical Conductivity and Ohm's Law - Experimental Electrical Resistivity of Metals - Motion in Magnetic Fields - Hall Effect - Thermal Conductivity of Metals - Ratio of Thermal to Electrical Conductivity.

Energy Bands: Nearly Free Electron Model - Origin of the Energy Gap - Magnitude of the Energy Gap - Bloch Functions - Kronig-Penney Model - Wave Equation of Electron in a Periodic Potential - Restatement of the Bloch Theorem - Crystal Momentum of an Electron - Solution of the Central Equation.

UNIT – V: **[18 Hrs]**

Semicondutor Crystals: Band Gap - Equations of Motion - Physical Derivation of $\hbar\dot{k}$ = F – Holes - Effective Mass - Physical Interpretation of the Effective Mass - Intrinsic Carrier Concentration - Intrinsic Mobility - Impurity Conductivity - Donor States - Acceptor States - Thermal Ionization of Donors and Acceptors.

Fermi Surface and Metals: Reduced Zone Scheme – Perodic Zone Scheme – Construction of Fermi Surfaces – Nearly Free Electrons – Electron Orbits, Hole Orbits and Open Orbits – Calculation of Energy Bands – Tight Binding Method for Energy Bands – Wigner-Seitz Method – Cohesive Energy – Experimental Methods in Fermi Surface Studies – Quantization of Orbits in a Magnetic Field – De Haas-van Alphen Effect – Extremal Orbits – Fermi Surface of Copper.

TEXT BOOK:

01. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Wiley India Pvt. LTd, New Delhi. (2017)

Unit- I: Chapters 1 and 2 (Relevant topics)

Unit- II: Chapter 3 (Relevant topics)

Unit- III: Chapters 4 and 5 (Relevant topics)

Unit- IV: Chapters 6 and 7 (Relevant topics)

Unit- V: Chapters 8 and 9 (Relevant topics)

REFERENCE BOOKS:

01. Ali Omar M., Elementary Solid State Physics – Principles and Application, Addison Wesley, New Delhi, 2000.
02. Animalu A.O.E., Intermedite Quantum Theory of the Crystalline Solid, Prentice Hall, New Delhi, 1977.
03. Ashcroft N.W., and Mermin N.D., Rinehart and Winston, Solid State Physics, Holt Publishers, New Delhi, 1976.
04. Kakani S.L., and Hemrajani C., Solid State Physics, Sultan, New Delhi, 2003.
05. Pillai S.O., Solid State Physics, New Age International Publishers, New Delhi, 1997.
06. Ziman J.M., Principles of the Theory of Solids, 2nd Edition, Cambridge, Chennai, 1972.

Core Subject **QUANTUM MECHANICS – II** **Code: 172104302**

SEMESTER III **6 Hrs/Week**

Credits 5

Objectives:

- ***To understand the concepts of scattering theory, Angular momentum time dependent Perturbation theory and Relativstic quantum theory.***

UNIT – I: **[15 Hrs]**

Scattering Theory: General Considerations: Kinematics of the scattering process: Differential and Total cross section – wave mechanical picture of scattering. The scattering Amplitude – Greens function: Formal expression for scattering amplitude.

The Born Approximations: The Born Approximation – Example: Screened and Coloumb Potential – validity of Born Approximation

Partial wave analysis: Asymptotic Behavior of partial waves: Phase shifts– the scattering amplitude interms of phase shifts – Differential and Total scattering cross section–Optical Theorem.

UNIT – II: **[15 Hrs]**

Representations, Transformation and symmetries Quantum States: State vectors and wave functions the Hilbert space of state vectors: Dirac notation – Dynamical variables and linear operators – Representation – continuous Basis – The Schrödinger representation – Degeneracy –labelling by commuting observables, change of basis, unitary transformations, Induced by change of coordinate system: Translation unitary transformation Induced by Rotation of coordinate system – space inversion – Time reversal.

UNIT – III: **[15 Hrs]**

Angular momentum: The Eigen value spectrum – Matrix Representation of J in the / jm > Basis–spin Angular Momentum – Addition of Angular momenta – clebsch – Gordon coefficients $j_1=j_2$ = ½ wave functions for a system of two spin half particles - Identical particles with spin

UNIT – IV: **[15 Hrs]**

Evolution with Time: Perturbation Theory for time Evolution problems: Perturbative solution for Transition Amplitude – selection Rules – First order Transitions: Constant Perturbation.

Alternative pictures of Time Evolution: The Schrödinger picture – the Heisenberg picture - Interaction picture.

UNIT – V: **[15 Hrs]**

Relativistic Equations: Generalization of Schrödinger equation: The Klein Gordon equation: Plane wave solutions: Charge and current densities – Interaction with Electro Magnetic Fields: Hydrogenlike Atom – nonrelativistic limit – The Dirac equation: Dirac's relativistic Hamiltonian – position probability density: Expectation values – Dirac Matrices – Plane wave solution of the Dirac Equation: Energy Spectrum – The spin of the Dirac Particle – Significance of Negative Energy states; Dirac Particle in Electromagnetic fields.

TEXT BOOK:

01. Mathews P.M., and Venkatesan K., Textbook of Quantum Mechanics, Tata McGraw – Hill Publishing Company Ltd., New Delhi, 2003. Relevant Chapters.

Unit	**Chapter**	
I	6	6.1 to 6.5, 6.8, 6.9, 6.10
II	7	7.1 to 7.9, 7.13, 7.14
III	8	8.1 to 8.3, 8.5 to 8.8
IV	9	9.5, 9.6, 9.7, 9.13, 9.16, 9.17, 9.21
V	10	10.2 to 10.10

REFERENCE BOOKS:

01. Schiff L.I., Quantum Mechanics, 3rd Edition, McGraw – Hill Book Company, New Delhi, 1968.
02. Kakani S.L., and Chandalia, Quantum Mechanics, Sultan Chand and Sons, New Delhi, IV ed., 2004.
03. Powell J.L., and Bernd Crass Man, Quantum Mechanics, Addision Wesley Publishing Co, New Delhi, IX Ed., 1998.

Core Subject **NUCLEAR PHYSICS** **Code: 172104303**

SEMESTER III

6 Hrs/Week
Credits 5

Objectives:

- ***To understand the concepts about the nuclear forces, models and reactions.***
- ***To get the knowledge about the elementary particles and elementary particle symmetries.***

UNIT – I: **[15 Hrs]**

Nuclear Forces: Introduction – Deuteron (Properties, No Excited S– states, Excited states of deuteron) Neutron – proton scattering at low energies (Scattering length, phase shift, spin dependence of nuclear force, coherent scattering) proton – proton scattering at low energies. Neutron – neutron scattering – similarity between (nn) and (pp) forces – Saturation of nuclear force (exchange forces) – Meson theory of nuclear force.

UNIT – II: **[15 Hrs]**

Nuclear models: Introduction, Fermi gas model, Liquid drop model, shell model, (Evidences for the existence of magic numbers, Extreme single particle model, Predictions of shell model only), collective nuclear model, unified model.

UNIT – III: **[15 Hrs]**

Nuclear Reactions: Types of nuclear reactions, conservation laws, Nuclear reaction Kinematics, Nuclear transmutations, Nuclear cross section – Partial wave analysis of reaction cross reaction – compound nucleus - Resonance cross reaction (Briet – Wigner dispersion formula) optical model.

UNIT – IV: **[15 Hrs]**

Nuclear fission and fusion, Nuclear reactors: Nuclear fission, types of fission, distribution of fission products, distribution of fission energy, Neutron emission in fission, fissile and fertile materials, spontaneous fission, deformation of liquid drop - Bohr and Wheeler's theory of nuclear fission, nuclear fusion and Thermo nuclear reactions – Controlled thermo nuclear reactions, Hydrogen bomb – fusion reactor (Pinched discharge and stellarator only).

Nuclear chain reaction – Four factor formula, general aspects of Nuclear reactor design.

UNIT – V: **[15 Hrs]**

Particle physics: classification of Elementary particles – fundamental interactions among particles – Quantum numbers

specifying states of particles – conservation law in production and decay processes – symmetry and conservation laws – special symmetry groups SU(2) and SU(3), Gellmann and Neeman classification of elementary paricles.

TEXT BOOKS:

01. Tayal D.C., Nuclear Physics, 4th Revised and Enlarged edition Himalaya Publishing House, Bombay, 2010.
    - UNIT – I: Chapter 8 – 8.1 to 8.3, 8.5, 8.7, 8.9(relevant sections), 8.12
    - UNIT – II: Chapter 9 - 9.1 to 9.4(relevant sections), 9.5, 9.6
    - UNIT – III: Chapter 10- 10.1 to 10.4 and 10.7, 10.9., 10.15, 10.20 to 10.21
    - UNIT – IV: Chapter 13, 13.1, 13.2, 13.3(relevant sections) 15.2, 15.4.
02. Satya Prakash, Nuclear Physics and Particle Physics, S. Chand and Sons, New Delhi.
    - UNIT – V: Chapter 11 - 11.5, 11.6, 11.7, 11.10, 11.11, 11.12, 11.13

REFERENCE BOOKS:

01. Sharma R.C., Nuclear Physics, revised 5th Edition, Nath K and Co, Meerut, 1992.
02. Pandya M.L., and Yadav R.P.S., Nuclear Physics, revised 7th Edition, Kedar Nath and Ram Nath, New Delhi, 2004.
03. Nigam B.P., and Roy R.R., Nuclear Physics, New Age International Pvt. Ltd, New Delhi, 1996.

Elective Major **MICROPROCESSOR** **Code: 172104304**
SEMESTER III **6 Hrs/Week**
Credits 5

Objectives:

- ***To understand the basic concepts of Microprocessor Programming and its interfacing techniques.***

UNIT – I: **[15 Hrs]**

Microprocessor architecture and its operation: Microprocessor – Initiated operations and 8085 Bus organization, Internal Data operations and the 8085 Registers – the 8085 MPU. Introduction to 8085 instructions: Data transfer operations, Arithmetic operations, Logic operations, Branch operations, writing assembly language programs debugging a program.

UNIT – II: **[15 Hrs]**

Programming Techniques with additional Instructions: Looping, Counting and Indexing, Additional Data transfer and 16 bit arithmetic instructions, Arithmetic operations related to memory, logic operations: Rotate and compare, Illustrative programs, Dynamic debugging.

UNIT – III: **[15 Hrs]**

Counters and time delays: Illustrative program: Hexadecimal counter, zero – to nine counter, Generating pulse waveforms,

Debugging counter and time delay programs. Stack and subroutines: Stack, Subroutine, Restart, conditional cell and return instructions advanced subroutine concepts.

UNIT – IV: **[15 Hrs]**

Interrupts: the 8115 Interrupts, 8115 Vectored interrupts, Illustrative Program: Interrupt – Driven clock, Restart as software instructions, Illustrative program : Implementation of Breakpoint technique. Interfacing Data Converters: Digital – to – Analog converters, Analog – to – Digital Converters

UNIT – V: **[15 Hrs]**

General – purpose programmable Peripheral Devices: The 8255A Programmable Peripheral Interface, Mode 0: Simple Input or output, BSR mode, Mode 1: Input or output with Handshake, Illustrative program. Illustrative program the 8254(8253) programmable Interval Timer, direct memory Access (DMA) and the 8237) DMA controller.

TEXT BOOK:

01. Ramesh Gaonkar, Microprocessor Architecture, Programming and applications with the 8115, 5th Edition, Penram International Publication, New Delhi, 1999.

UNIT – I:	Chapter 3, Section 3.1 only
	Chapter 4, Section 4.1 only.
	Chapter 6, Section 6.1 to 6.6
UNIT – II:	Chapter 7, Sections 7.1 to 7.6
UNIT – III:	Chapter 8, Sections 8.1 to 8.5
	Chapter 9, Sections 9.1 to 9.4
UNIT – IV:	Chapter 12, Sections 12.1 to 12.3
	Chapter 13, Section 13.1 and 13.2
UNIT – V:	Chapter15, Section 15.1,15.4–15.6 only

REFERENCE BOOKS:

01. Aditya P.Mathur, Introduction to Microprocessors, 3rd Edition, Tata McGraw – Hill Publishing Co. New Delhi.
02. Douglas V.Hall, Microprocessor Interfacing Programming and Hardware, 2nd Edition, Tata McGraw – Hill Publishing Co, New Delhi.
03. Ram B., Fundamentals of Microprocessors and Microcomputers, 4th Edition, Dhanpatraj, New Delhi, 1993.

Self–Learning Course **BIO-PHYSICS** **Code: 178004321**

SEMESTER III

Addl. Credits 3

Objectives:

- ***To stimulate the skills of the PG students towards the understanding of the physical principles behind the biological systems.***

UNIT – I:

Bio –Physics and Fluid Flow: Steady Laminar Flow – Poiseuille's Formula – Energetics of fluid flow – Turbulence – Hemodynamics – Fluid flow in plants – Biophysics and Gas transport – The Ideal gas –

convective Transport of Gases – Diffusion of gases: Fick's Laws – physiology of Respiration.

UNIT – II:

Physics of Audition: Transverse and Longitudinal waves – physiological characteristics of sound – Human Ear – phase sensitivity and Determination of Direction – Doppler effect – Physics of vision– wave nature of light – Geometrical optics – Refractive power – Retina and Photoreceptors – Photoreceptors and Fiber optics – Resolving power of Eye – polarisation and vision.

UNIT – III:

Cellular – Molecular Biophysics: Cell organelles and Molecules – Prokaryotes and Eukaryotes – Molecular components of cell – carbohydrates – Lipids – proteins – Nucleic Acids – Hetero macromolecules.

UNIT – IV:

Physics of Bio-molecules: Molecular Forces – strong force – Inter–molecular weak Forces – structural organization of proteins – structural organization of Nucleic Acids – Molecular Mechanism of Genetic Information Transfer – Genetic code – Transfer of Genetic information – Molecular Mechanism of Protein synthesis – principle of molecular Recognition.

UNIT – V:

Thermodynamics and Bio–Systems: Equilibrium Thermodynamics – Near – Equilibrium Thermodynamics – Gibbs Free Energy – chemical potential – Thermodynamic Analysis of Membrane Transport – Phase Equilibrium – More on Irreversible Thermodynamics.

TEXT BOOK:

01. Srivastava P.K., Elementary Biophysics, An Introduction, Narosa Publishing House Pvt., Ltd., 2006.

REFERENCE BOOK:

01. Narrayanan P., Essentials of Biophysics, New Age International Publishers.

Core Subject **SOLID STATE PHYSICS – II** **Code: 172104401**

SEMESTER IV

6 Hrs/Week
Credits 5

Objectives:

- ***To understand the basic concepts of Solid State Physics***
- ***To apply the theory to latest developments in Solid State Physics***

UNIT – I: **[18 Hrs]**

Superconductivity: Experimental Survey - Occurrence of Superconductivity - Destruction of Superconductivity by Magnetic Fields - Meissner Effect - Heat Capacity - Energy Gap - Isotope Effect - London Equation - Coherence Length - BCS Theory of Superconductivity - BCS Ground State - Flux Quantization in a Superconducting Ring - Duration of Persistent Currents - Type II Superconductors - Vortex State - Estimation of H_{c1} and H_{c2} - Single Particle Tunneling - Josephson Superconductor Tunneling – Dc Josephson Effect - Ac Josephson Effect - Macroscopic Quantum Interference.

UNIT – II: **[18 Hrs]**

Diamagnetism and Paramagnetism: Langevin Diamagnetism Equation - Quantum Theory of Diamagnetism of Mononuclear Systems - Paramagnetism - Quantum Theory of Paramagnetism - Hund Rules - Iron Group Ions - Crystal Field Splitting - Quenching of the Orbital Angular Momentum - Spectroscopic Splitting Factor - Van Vleck Temperature-Independent Paramagnetism.

Ferromegnetism and Antiferromegnetism: Ferromagnetic Order - Curie Point and the Exchange Integral - Temperature Dependence of the Saturation Magnetization - Magnons - Quantization of Spin Waves - Thermal Excitation of Magnons - Ferrimagnetic Order - Curie Temperature and Susceptibility of Ferrimagnets - Antiferromagnetic Order - Susceptibility Below the Neel Temperature - Ferromagnetic Domains - Anisotropy Energy - Transition Region between Domains - Origin of Domains.

UNIT – III: **[18 Hrs]**

Plasmons, Polaritons, and Polarons: Dielectric Function of the Electron Gas - Definitions of the Dielectric Function - Plasma Optics - Dispersion Relation for Electromagnetic Waves - Transverse Optical Modes in a Plasma - Transparency of Metals in the Ultraviolet - Longitudinal Plasma Oscillations - Plasmons - Electrostatic Screening - Screened Coulomb Potential - Pseudopotential Component U(0) - Polaritons - LST Relation - Electron-Electron Interaction - Fermi Liquid - Electron-Electron Collisions - Electron - Phonon Interaction: Polarons.

Optical Processes and Excitons: Optical Reflectance - Kramers-Kronig Relations – Excitons - Frenkel Excitons - Alkali Halides - Molecular Crystals - Weakly Bound (Mott-Wannier) Excitons

- Exciton Condensation into Electron-Hole - Drops (EHD) - Raman Effect in Crystals.

UNIT – IV: **[18 Hrs]**

Dielectrics and ferroelectrics: Maxwell Equations - Polarization - Macroscopic Electric Field - Depolarization Field - Local Electric Field at an Atom - Lorentz Field - Field of Dipoles Inside Cavity - Dielectric Constant and Polarizability - Electronic Polarizability - Classical Theory of Electronic Polarizability - Ferroelectric Crystals - Classification of Ferroelectric Crystals - Displacive Transitions - Landau Theory of the Phase Transition - Second-Order Transition - First-Order Transition - Antiferroelectricity - Ferroelectric Domains - Piezoelectricity.

UNIT – V: **[18 Hrs]**

Point Defects: Lattice Vacancies - Color Centers - F Centers - Other Centers in Alkali Halides.

Dislocations: Slip – Dislocations - Burgers Vectors - Stress Fields of Dislocations - Dislocations and Crystal Growth – Whiskers - Hardness of Materials.

Alloys: Substitutional Solid Solutions - Hume-Rothery Rules - Order-Disorder Transformation - Elementary Theory of Order – Kondo Effect.

TEXT BOOK:

01. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Wiley India Pvt. LTd, New Delhi. (2017)

    Unit- I: Chapters 10 (Relevant topics)

    Unit- II: Chapter 11 & 12 (Relevant topics)

    Unit- III: Chapter 14 & 15 (Relevant topics)

    Unit- IV: Chapters 16 (Relevant topics)

    Unit- V: Chapters 20, 21 and 22 (Relevant topics)

REFERENCE BOOKS:

01. Ali Omar M., Elementary Solid State Physics – Principles and Application, Addison Wesley, New Delhi, 2000.
02. Animalu A.O.E., Intermedite Quantum Theory of the Crystalline Solid, Prentice Hall, New Delhi, 1977.
03. Ashcroft N.W., and Mermin N.D., Rinehart and Winston, Solid State Physics, Holt Publishers, New Delhi, 1976.
04. Kakani S.L., and Hemrajani C., Solid State Physics, Sultan, New Delhi, 2003.
05. Pillai S.O., Solid State Physics, New Age International Publishers, New Delhi, 1997.
06. Ziman J.M., Principles of the Theory of Solids, 2nd Edition, Cambridge, Chennai, 1972.

Core Subject **APPLIED OPTICS AND NON LINEAR DYNAMICS**

SEMESTER IV **Code: 172104402**

6 Hrs/Week

Credits 5

Objectives:

- ***To analyse optical problems with the help of approximations made in fourier optics.***
- ***To build a thorough understanding of principles involved in non linear optical phenomena.***
- ***To explain the basics of Non linear dynamics.***

UNIT – I: **[16 Hrs]**

Matrix methods in Gaussian optics. The use of matrices to describe linear transformations – the matrices for refraction and translation transformations matrices for simple systems – the image formation process – the combination of two image - forming systems – Nodal points. Interference by reflections from non–identical interfaces: reflection reducing coating – reflection enhancing coating. Interference by multiple reflection – general derivation – Fabry-perot Interferometer – Spectrometry with fabry – perot etalon.

UNIT – II: **[17 Hrs]**

Fourier optics: Foundations of Scalar diffraction theory: Historical Introduction – From a vector to a scalar theory – some mathematical preliminaries - The Kirchhoff formulation of Diffraction by a planar screen – The Rayleigh Sommerfeld formulation of diffraction – Comparison of the Kirchhoff and Rayleigh - Sommerfeld theories – Further discussion of the Huygen's – Fresnel principle – Fresnel and Fraunhofer diffraction: Background – The Fresnel approximation – The Fraunhofer approximation – Examples for Fraunhofer diffraction patterns (rectangular Aperture and circular aperture only).

UNIT – III: **[15 Hrs]**

Wave – optics Analysis of coherent optical systems: A thin lens as a phase transformation – Fourier Transforming properties of lenses - Frequency analysis of optical imaging system: generalized treatment of imaging systems – frequency response for diffraction – limited coherent imaging – frequency response for diffraction limited incoherent imaging.

UNIT – IV: **[15 Hrs]**

Dynamical Systems: Linear and nonlinear forces – Working definition of nonlinearity – Linear oscillators and Predictability – free oscillations - Damped oscillations – Forced oscillations – Primary

Resonance and jump phenomenon (hysteresis) – dynamical systems as coupled first – order, Differential Equation: Equilibrium points – Classification of equilibrium points – two dimensional case – general criteria for stability – Classification of equilibrium points (up to case 5 only) - Limit cycle motion – periodic Attractor – Poincare – Bendixson theorem.

UNIT – V: **[12 Hrs]**

Bifurcations and onset and Chaos in Dissipative Systems: Some simple Bifurcations – saddle – Node Bifurcation – the pitchfork Bifurcation – transcritical Bifurcation – Hope Bifurcation – Discrete Dynamical systems: The Logic Map – Equilibrium points and their stability – stability when the first derivative equals to +1 or -1-periodic solutions or cycles – periodic doubling phenomenon – Onset of chaos: Sensitive Dependence on initial conditions – Lyapunov Exponent.

TEXT BOOKS:

01. Miles V.Klein, Optics Wiley and Sons INC, New Delhi.

    Unit I: Chapter 3 - 3.4,A to 3.4 F

    Chapter 5 - 5.5 A,5.5 B, 5.6 A.

02. Goodman J.W., Introduction to Fourier Optics Wiley and Sons, 3rd Edition, first Indian edition, New Delhi, 2007.

    Unit II: Chapter 3 - 3.1 to 3.7.

    Chapter 4 - 4.1 to 4.3, 4.4 – 4.4.1, 4.4.2

    UNIT III Chapter 5 - 5.1 to 5.2.

    Chapter 6 - 6.1 to 6.3..

03. Lakshmanan M., and Rajasekar S., Nonlinear dynamics, Integrability, 3rd Indian reprint Chars and Patterns, Springer (India) Private Ltd., India, 2009.

    Chapter 1 – 1.1, 1.3
    Chapter 2 – 2.1-2.1.1 to 2.1.3 } UNIT - IV
    2.2-2.2.1 to 2.2.3
    Chapter 3 - 3.2, 3.4-3.4.1, 3.4.2,
    3.5 -3.5.1
    Chapter 4 – 4.1- 4.1.1 to 4.1.4 } UNIT - V
    4.2-4.2.1 to 4.2.6

REFERENCE BOOKS:

01. Fowles G.R., Introduction to Modern optics, Holt Publication, New Delhi.

02. Robert C. Hilborn; Chaos and Nonlinear Dynamics; 2nd Edition; Oxford University Press, Indian Edition.

Core Subject **MOLECULAR SPECTROSCOPY** **Code: 172104403**

SEMESTER IV **6 Hrs/Week**

Credits 5

Objectives:

- ***To understand the basic concepts in Molecular spectroscopy.***

UNIT – I: **[15 Hrs]**

Introduction: Electromagnetic spectrum- Types of molecular energies- Classification of molecules- Linear molecules- Symmetric tops- Spherical tops- Asymmetric tops- Interaction of radiation with rotating molecule- Rotational spectra of rigid diatomic molecules- Isotope effect in rotational spectra- Intensity of rotational lines- Non-rigid rotator- Vibrational excitation effect- Linear polyatomic molecules- Symmetric top molecules- Asymmetric top molecules- Microwave spectrometer.

UNIT – II: **[15 Hrs]**

Infra-red Spectroscopy: Vibrational energy of a diatomic molecule- Infrared spectra- preliminaries - Infrared selection rules - Vibrating diatomic molecule - Diatomic vibrating rotator- Asymmetry of rotation vibration band - Vibrations of polyatomic molecules- Normal vibrations of CO_2 and H_2O molecules- Dipole moment change in CO_2 molecule- Nomenclature of internal modes- More about anharmonicity - Fermi Resonance- Hydrogen Bonding- Rotation-Vibration spectra of polyatomic molecules- Linear molecules- Nuclear spin effects- Symmetric top molecules- IR spectrophotometer- Instrumentation- Sample handling techniques- Fourier transform infrared spectroscopy.

UNIT – III: **[15 Hrs]**

Raman Scattering: Introduction- Theory of Raman scattering – Classical Theory- Quantum Theory- Rotational Raman spectra- Linear molecules- Symmetric top molecules- Vibrational Raman spectra- Mutual exclusion principle- Raman spectrometer- Sample handling techniques- Electronic Spectra of Diatomic Molecules- Introduction- Vibrational coarse structure- Franck- Condon principle- Intensity of vibrational electronic spectra- Rotational fine structure of electronic-vibration spectra - The Fortrait Parabolae- Dissociation- Predissociation.

UNIT – IV: **[17 Hrs]**

Nuclear Magnetic Resonance: Magnetic properties of Nuclei- Resonance Condition- NMR instrumentation- Relaxation processes - Bloch Equations- Dipolar interaction- Chemical shift- NMR imaging-

Interpretation of certain NMR spectra. Proton NMR spectrum of 1-Nitropropane- Proton spectrum of Methyl ethyl ketone.

UNIT – V: **[13 Hrs]**

Electron Spin Resonance: Introduction- Principle of ESR- ESR spectrometer- Total Hamiltonian- Hyperfine structure- ESR Spectrum of hydrogen atom- One electron system coupled to a Nucleus of spin I=1- Unpaired electron coupling with two equivalent nuclei of spin I=½- Unpaired electron coupling with two non-equivalent nuclei each of spin I= ½- Some other systems of interest- ESR spectra of Free radicals in solution- Energies of radicals with one unpaired electron- $^{\bullet}CH_3$ Radical- Benzene Anion, $C_6H_6^-$ - p- Nitrobenzoate Dianion- EPR of transition metal ions- Ground Terms of Free Ions- Crystal field effects- splitting of states and transitions.

TEXT BOOKS:

01. G. Aruldhas, Molecular Structure and Spectroscopy- 2nd Edition, Prentice Hall of India Private Limited.
    - UNIT-I: Chapter 1: Sections 1.1-1.2.
      Chapter 6: Sections 6.1-6.10, 6.14.
    - UNIT-II: Chapter 7: Sections 7.1-7.11, 7.16-7.18.
    - UNIT-III: Chapter 8: Sections 8.1-8.7.
      Chapter 9: Sections 9.1, 9.2, 9.6-9.10.
    - UNIT-IV: Chapter10: Sections 10.1-10.3, 10.5-10.8,10.19-10.20.
    - UNIT-V : Chapter 11: Sections 11.1- 11.6.4, 11.9- 11.9.3.

REFERENCE BOOKS:

01. Colin. N. Banwell and Elaine M. McCash, Fundamentals of Molecular Spectroscopy, 5th Edition, McGraw, Hill Education (India) Private Limited.
02. Gurudeep R. Chatwal and Sham K. Anand, Spectrosocpy, Himalaya Publishing House.

Core Lab

ADVANCED PHYSICS EXPERIMENTS **Code: 172104404**
SEMESTER III & IV **3 Hrs/Week**
Credits 3

ANY TWELVE

01. Variable power supply using IC 723.
02. Amplitude modulation & Demodulation.
03. Active filters using IC 741.
04. Four Probe Method (Band Energy gap).
05. Refractive index of the liquid using laser.
06. Analog computation using IC 741.
07. Quinke's method – Susceptibility measurement.
08. Hall Experiment – Hall Coefficient.

09. Pulse Width Modulation using IC 555.
10. Familiarization of Excel.
11. 4 bit D/A converter.
12. 4 bit binary counter.
13. I-V Characteristics of Diode, Capacitor, LED and Inductor using microprocessor.
14. Square wave generation and ramp generation using microprocessor.
15. Shift Register using JK Flip Flops.
16. Fibre Optic Communication.
17. X-Ray powder diffraction – Accurate cell parameter determination.
18. Fraunhofer diffraction using Laser.

Elective Major **NANO SCIENCE** **Code: 172104405**
SEMESTER IV

6 Hrs/Week
Credits 5

Objectives:

- ***To understand the basic concepts of nano science.***
- ***To apply the concepts to various physical systems.***

UNIT – I: **[15 Hrs]**

Introduction to physics of the solid state: Structure – Size dependence of properties, crystal structures – Face Centered Cubic Nanoparticles – Tetrahedrally bonded semiconductor structure – Lattice vibrations – Energy bands – Insulators, semiconductors and conductors – Reciprocal space – Energy bonds and gaps of semiconductors – Effective masses – Fermi surfaces – Localized particles – Donors, Acceptors and Deep traps – Mobility – Excitons.

UNIT – II: **[15 Hrs]**

Methods of measuring properties: Introduction – Structure – Atomic structure – Crystallography – Particle size determination – Surface structure – Microscopy – Transmission electron microscopy – Field ion microscopy – Scanning microscopy – Spectroscopy – Infrared and Raman spectroscopy – Photoemission and X-Ray spectroscopy – Magnetic Resonance.

UNIT – III: **[15 Hrs]**

Properties of individual nano particles: Metal nanoclusters – Magic numbers – Theoretical modeling of nano particles – Geometric structure Electronic structure – Reactivity – magnetic clusters – Bulk to nano transition - Semi conducting nano particles – optical

properties – photo fragmentation – columbic explosion – methods of synthesis – RF plasma – chemical methods – Thermolysis – pulsed LASER methods.

UNIT – IV: **[15 Hrs]**

Carbon Nano Structures: Introduction carbon molecules – Nature of Carbon bond – New Carbon structures – Carbon Clusters: Small carbon clusters – Discovery of C_{60} – Structure of C_{60} and its crystal – Alkali-doped C_{60} – Superconductivity in C_{60} – Larger and Smaller fullerences – Other Buckyballs – Carbon Nanotubes – Fabrication – Structure – Electrical properties – Vibrational properties – Mechanical properties.

UNIT – V: **[15 Hrs]**

Quantum Wells, Wires and Dots: Introduction – Preparation of quantum nanostructures – Size and Dimensionality effects – Size effects – Conduction electrons and dimensionality – Fermi gas and density of states – Potential wells – Partial confinement – Properties dependent on density of states – Excitons – Organic compounds and polymers: Introduction – Forming and characterizing polymers – Polymerization – Sizes of polymers – Nano crystals – Condensed ring types – Polydiacetylene types – Polymers – Conducting polymers – Block copolymers.

TEXT BOOKS:

01. Charles P.Poole Jr, Frank J.Owens, Introduction to Nano Technology, John Wiley and Sons Private limited, 2008.

UNIT – I: Chapter 2 all sections

UNIT – II: Chapter 3 all sections

UNIT – III: Chapter 4, 4.2,4.3, 4.5

UNIT – IV: Chapter 5, 5.1, 5.2, 5.3, 5.4,5.5

UNIT – V: Chapter 9, 9.1, 9.2, 9.3, 9.4,9.5, 9.6
Chapter 11, 11.1 to 11.4

REFERENCE BOOKS:

01. Debabrata Goswami, Nano Computing - Vishal Sahni, Tata McGraw – Hill Publishing Company Limited, New Delhi, 2008.
02. Murty B.S., Shankar P., Baldev Raj, B.B. Rath, James Murday Tools to Charaterize nano materials, CRC press (2013).
03. Haghi A.K., Ajesh K., Zachariah, Nanda kumar, Kalariakkal, Nanomaterials; synthesis, Characterization and Applications CRC Press (2013).

Elective Major **PROJECT** **Code: 172104406**

SEMESTER IV **3 Hrs/Week**

Credits 4

Students have to carry out project works under the guidance of the members of the Physics Department during III and IV semesters 3 hours per week. Each batch may be chosen in the fields of theoretical physics, spectroscopy, electronics, crystallography, thin films and Nanomaterials. Each batch will complete the project work in the month of March and submit their report.

It will be duly signed by the project guide and Head of the Department of Physics. The Viva on project will be conducted druing the practical examination at the end of IV semester.

	Internal	External
Project	24	36
Viva	16	24
Total	40	60

Self–Learning Course **INFORMATION TECHNOLOGY**

SEMESTER IV **Code: 178004421**

Addl. Credits 3

Objectives:

- ***To understand the basic concepts in Information technology.***
- ***To get knowledge about various Communication system.***

UNIT – I:

Introduction – What is information – What constitutes the information technology? Database Management Systems – Introduction – Need for Development of DBMS – Viewing Data in a DBMS – Data Models.

UNIT – II:

Role of telecommunication in information technology: Introduction – Information and the channel capacity – Other classifications of signals – Concept of signal to noise ratio – Modulation schemes – Communication Network – Transmission through wires (cables and fibres) – The Telephone system – wireless communications– Satellite communications – Cellular Telephone System – Conclusion.

UNIT – III:

Introduction – Circuit and packet switching – Web site – Home page – Domain Name System (DNS) – Name server – IP Address – What is TCP/IP? – HTTP – IP Address – Balancing the load on the internet servers – Uniform Resource Locator (URL) – Client server model – Client and the Browser – The server –Proxy Server – HTTP and HTML – Java, the Language of the internet – Security – A concern – How to go about Surfing the net – What you can do on the net – Conclusion.

UNIT – IV:

Overview of Present Day Networking Technologies: Introduction – Down the layers – The layer 2 – The LAN Technologies – The WAN Technologies – Layer 3 – IP routing protocols – Multicasting – quality of service – Integrated service and RSVP – Lower level Qos support – Qos implementation by queuing and congestion Avoidance – Security – Network Management – Other Protocols

UNIT – V:

Information Technology for multimedia communication: Introduction – Multimedia Application – The Human perceptual system – Analog Representation of perceptual Information – Digital Representation and Coding of Visual Information – Third Generation cellular Telephony for multimedia Communication – Advance Multimedia coding standards – speech Coding Standards – Text Compression Standards.

TEXT BOOK:

01. Ajoy Kumar Ray, Information Technology – Principles and Applications, Prentice Hall of India, New Delhi – 110001.

REFERENCE BOOKS:

01. Douglas E.Comer, The Internet, 3rd Edition, Pearson Education, New Delhi, 2003.
02. Rajaraman V., Fundamentals of Computersm 4th Edition, Prentice Hill Pvt., Ltd., New Delhi.

M.Sc PHYSICS: Those who have joined in the academic year 2017–18 onwards under CBCS System

EVALUATION PATTERN

Internal : 25 Marks

External : 75 Marks

INTERNAL:

Test –15 (average of the better two of the three tests conducted)

Assignment – 5

Seminar – 5

Question Paper Pattern:

INTERNAL	**EXTERNAL**
Part – A : 4 × 1 = 4	Part – A :5/7 × 2 = 10
Part – B : 3 × 4 = 12	Part – B : 5 × 7 = 35
(Either/ Or)	(Either /Or)
Part – C : 2/3 ×7 = 14	Part – C : 3/5×10 = 30
*30	75

* Internal test mark 30 will be converted to 15.