J.J. COLLEGE OF ARTS AND SCIENCE, PUDUKKOTTAI – 622 422.

M.Sc. Physics Course Structure under CBCS

(For the candidates admitted from the academic year 2016-2017 onwards)

Semester	Code	Course	Title	Instr. Hours/Week	Credit	Exam Hours	Marks		Total
							Int.	Extn.	
I	P1RPHCC1	Core Course – I	Mathematical Physics	6	5	3	25	75	100
	P1RPHCC2	Core Course – II	Classical Dynamics and Relativity	6	5	3	25	75	100
	P1RPHCC3	Core Course – III	Electronics –I	6	5	3	25	75	100
	P1RPHCC4P	Core Course – IV	Physics Practical- I	6	5	4	40	60	100
	P1RPHEC1	Elective Course – I	Numerical methods and Computational Physics	6	3	3	25	75	100
			Total	30	23				500
II	P2RPHCC5	Core Course – V	Electromagnetic Theory	5	5	3	25	75	100
	P2RPHCC6	Core Course – VI	Quantum Mechanics	5	5	3	25	75	100
	P2RPHCC7	Core Course – VII	Statistical Mechanics	5	5	3	25	75	100
	P2RPHCC8	Core Course – VIII	Electronics –II – Microprocessor and microcontroller	5	5	3	25	75	100
	P2RPHCC9P	Core Course – IX	Physics Practical-II	6	5	4	40	60	100
	P2RPHCC10	Elective Course – I I	Crystal Growth and Thin Films	4	3	3	25	75	100
			Total	30	28				600

J.J. COLLEGE OF ARTS AND SCIENCE, PUDUKKOTTAI – 622 422.

M.Sc. Physics Course Structure under CBCS

(For the candidates admitted from the academic year 2016-2017 onwards)

Semester	Code	Course	Title	Instr. Hours/ Week	Credit	Exam Hours	Marks		Total
							Int.	Extn.	
III	P3RPHCC10	Core Course – X	Solid State Physics	6	5	3	25	75	100
	P3RPHCC11	Core Course – XI	Atomic and Molecular spectroscopy	6	5	3	25	75	100
	P4RPHCC12P	Core Course – XII	Physics Practicals – III	3	***	***	***	***	***
	P4RPHCC13P	Core Course – XIII	Physics Practicals–IV	3	***	***	***	***	***
	P3RPHEC3	Elective Course –III	Nano Science and Nano Technology	6	3	3	25	75	100
	P3RPHEC4	Elective Course –IV	Non Linear Optics	6	3	3	25	75	100
			Total	30	16				400
IV	P4RPHCC12P	Core Course – XII	Physics Practicals – III	3	5	4	40	60	100
	P4RPHCC13P	Core Course – XIII	Physics Practicals – IV	3	5	4	40	60	100
	P4RPHCC14	Core Course – XIV	Nuclear and Particle Physics	6	5	3	25	75	100
	P4RPHCC15PW	Core Course – XV Project Work	Dissertation 80 Marks [2 reviews– 20+20 = 40 marks Report Valuation = 40 marks] Viva = 20 Marks	18	8	***	***	***	100
			Total	30	23				400
			Grand Total		90				1900

J.J Colleg of Arts and Science (Atonomous)

Sivapuram, Pudukkottai – 622 422

Department of Physics

Course structure for M.Sc (physics) program Under Choice based Credit System for 2016 – 2017 onwards

* Physics Practical examination at the end of every semester Elective Courses:

1. Numerical Methods and Computational Physics
2. Crystal Growth and Thin film Physics
3. Nanoscience and Technology
4. Non Linear Optics

SEM: I **HOURS: 6**

PAPER CODE: P1RPHCC1 **CREDIT: 5**

CC I: MATHEMATICAL PHYSICS

Objectives:

To understand various mathematical techniques and concepts

To practice mathematical methods for physics through vector analysis, matrices, tensors, complex analysis, special functions and group theory

Unit 1: Vector analysis

Concept of vector and scalar fields – Gradient, divergence, curl and Laplacian – Vector identities – Line integral, surface integral and volume integral – Gauss theorem, Green's Theorem, Stoke's theorem and applications – Orthogonal curvilinear coordinates – Expression for gradient, divergence, curl and Laplacian in cylindrical and spherical co-ordinates.

Unit 2: Tensors and Matrix Theory

Transformation of coordinates – Summation convention – Contravariant, covariant and mixed tensors – Rank of a tensor – Symmetric and antisymmetric tensors – contraction of tensor – Characteristic equation of a matrix – Eigen values and eigenvectors – Cayley - Hamilton theorem - Reduction of a matrix to diagonal form – Jacobi method – Sylvester's theorem.

Unit 3: Complex Analysis

Functions of complex variables – Differentiability -- Cauchy-Riemann conditions – Complex integration – Cauchy's integral theorem and integral formula – Taylor's and Laurent's series – Residues and singularities - Cauchy's residue theorem – Evaluation of definite integrals.

Unit 4: Special Functions

Gamma and Beta functions – Sturm-Liouville problem – Legendre, Associated Legendre, Bessel, Laugerre and Hermite differential equations : series solution – Rodriguez formula – Generating functions – Orthogonality relations – Important recurrence relations

Unit 5: Group Theory

Basic definitions – Multiplication table – Subgroups, Cosets and Classes – Direct Product groups – Point groups -- Space groups – Representation theory – Homomorphism and isomorphism– Reducible and irreducible representations – Schur's lemma – The great Orthogonality theorem – Character table -- C3v and D3h as examples – Elementary ideas of rotation groups.

Books for Study

1. Mathematical Physics ,Sathya prakash, , Sultan Chand & sons, Fifth revised and enlarged edition, 2006, New Delhi – 110 002. (Unit I - IV)
2. Chemical Applications of Group Theory, F.A. Cotton, (Wiley Eastern, New Delhi, 1987). (Unit- V)

Books for Reference:

1. Matrices and Tensors in Physics, A.W. Joshi, Wiley Eastern Ltd., New Delhi (1975)
2. Applied Matematics for Engineers and Physcists, L.A.Pipes and L.R. Harvill, McGraw Hill Company, Signgapore (1967)
3. Mathematical Physics,P.K.Chattopadhyay, Wiley Eastern Ltd., New Delhi (1990)
4. Mathematical Physics,A.K. Ghattak, T.C.Goyal and S.J. Chua, Macmillan, New Delhi (1995)
5. Methods for Physicists G.Arfken and H.J.Mathemattical, 4^{th} ed. Physicists (Prism Books, Banagalore, 1995).
6. Special Functions for Scientists and Engineers W.W.Bell, (Van Nostrand, New York, 1968) .

SEM: I **HOURS: 6**

PAPER CODE: P1RPHCC2 **CREDIT: 5**

CC II: CLASSICAL DYNAMICS AND RELATIVITY

Objectives:

To understand the fundamental principles of classical mechanics and their applications

To understand Lagrangian and Hamiltonian principles and its applications

To study the canonical transformations of Poisson's Brackets & Hamilton – Jacobi Theory

To study the general theory of small oscillations and Rigid body dynamics

To study the energy concepts in relativistic mechanics.

Unit 1 : Fundamentals of classical mechanics

Mechanics of a particle and system of particles – Conservation laws – Constraints – Generalized coordinates – D' Alembert's principle and Lagrange's equation – Hamilton's principle – Lagrange's equation of motion – conservation theorems and symmetry properties – Motion under central force : General features – The Kepler problem Scattering in a central force field.

Unit 2: Lagrangian Formulation: Applications

a) Rigid Body Dynamics

Euler angles – Moments and products of inertia – Euler's equations – Symmetrical top.

b) Oscillatory Motion

Theory of small oscillations – Normal modes and frequencies – Linear triatomic molecule

Wave motion – wave equation – Phase velocity – Group Velocity dispersion

Unit 3: Hamilton's Formulation

Hamilton's canonical equations of motion – Hamilton's equations from variational principle – Principle of least action – Canonical transformations – Poisson brackets – Hamilton – Jacobi method – Action and angle variables – Kepler's problem in action – angle variables.

Unit 4: Nonlinear Dynamics

Linear and nonlinear oscillators- phase trajectories – Period doubling phenomenon in Duffing oscillator.

Soliton: Linear and nonlinear waves – Solitary Waves – KdV equation – Numerical experiments of Kruskal and Zabusky – Solitons.

Unit 5: Relativistic mechanics

Reviews of basic ideas of special relativity – Energy momentum four vector – Minkowski's four dimensional space – Lorentz transformation as rotation in Minkowski's space – Compositions of L.T. about two orthogonal directions – Thomas precession – Invariance of Maxwell's equations under Lorentz transformation – Elements of general theory of relativity.

Books for study

1. Classical Mechanics,H.Goldstein, Narosa Book distributors, New Delhi (1980)
2. Nonlinear Dynamics M.Lakshmanan and S.Rajasekar:: Integrability, Chaos and Patterns, Springer – Verlag, Berlin (2003), Springer (India) 2004
3. Chaos in Nonlinear Oscillators,M.Lakshmanan and K.Murali: world Scientific Co., Singapore (1996). Chapters 2-4.

Books for Reference

1. Classical Mechanics,N.C.Rana and P.S.Joag Tata Mc: Graw Hill, New Delhi (1991)

SEM: I **HOURS: 6**

PAPER CODE: P1RPHCC3 **CREDIT: 5**

CC-III: ELECTRONICS-I

Objectives:

To study the fabrication of semiconductor devices

To study the constructions, operations and characteristics of solid state devices

To learn the circuit operation of Op-amp and 555 timer applications.

Unit 1: Semi Conductor Diodes:

The continuity equation – Application of the continuity equation for an abrupt PN junction under forward and reverse bias – Einstein equation – Varactor diode – Schottky diode – Tunnel diode – Gunn diode – Optoelectronic diodes – LASER diode, LED and photo diode.

Unit 2: Special Semiconductor Devices:

JFET- Structure and working – I -V Characteristics under different conditions – biasing circuits –

CS amplifier design – AC analysis – MOSFET: Depletion and Enhancement type MOSFFT – UJT characteristics – relaxation oscillator – SCR characteristics – control circuits using SCR, DIAC and TRIAC.

Unit – 3 Operational Amplifier

Operational amplifier characteristics – inverting and non-inverting amplifier – instrumentation amplifier – voltage follower –integrating and differential circuits –log & antilog amplifiers – op-amp as comparator – Voltage to current and current to voltage conversions-active filters : low-pass, high pass, band pass -Solving simultaneous and differential equations.

Unit – 4 : Op-Amp Applications (Oscillators and Convertors)

Wien bridge, phase shift oscillators–triangular, saw-tooth and square wave generators-Schmitt's trigger – sample and hold circuits – Voltage control oscillator – phase locked loops. Basic D to A conversion: binary weighted resistor DAC – Binary R-2R ladder DAC – Basic A to D conversion: counter type ADC – successive approximation converter – dual slope ADC.

Unit – 5: IC Fabrication and Timer

Basic monolithic ICs – epitaxial growth – masking –etching impurity diffusion-fabricating monolithic resistors, diodes, transistors, inductors and capacitors – Fabrication of BJT-FET - IC 555 timer – description of the functional diagram – mono stable operation – Astable operation.

Books for Study

1. Electronic devices and circuits, S.Sallaivahanan, N.Suresh kumar and A.Vallavaraj, Tata McGraw-Hill Publishing Company Lited, New Delhi.

2. Linear integrated circuits S.Roy Chaudri, Shail Jain, , New age International (P)Limited, New Delhi.

3. Op-Amps&Linear integrated circuits, R.A.Gayakwad, Printice Hall India Pvt Ltd.(1999)

Refrence Books:

1. Electronic device and circuits,G.K.Mittal, Printice Hall India Pvt Ltd.(1999)
2. Active and Nonlinear Electronics,T.F.Schubert and E.M.Kim, John Wiley Sons, New York (1996)
3. Electronic Devices, L.Floyd, "Pearson Education" New York (2004)
4. Transitors, Dennis Le Crissitte, Printice Hall India Pvt. Ltd (1963)
5. Physices of Semiconductor Devices, S.M.Sze, Wiley-Eastern Ltd (1981)

SEM: I **HOURS: 6**

PAPER CODE: P1RPHCC4P **CREDIT: 5**

CC - IV: PHYSICS PRACTICAL - I

(General & Electronics)

Any fifteen Experiments (choosing a minimum of six experiments from each part)

A. General Experiments

1. Determination of q, n, b by elliptical fringes method
2. Determination of q, n, b by hyperbolic fringes method
3. Determination of bulk modulus of a liquid by ultrasonic wave propagation
4. Determination of Stefan's constant
5. Identification of prominent lines by spectrum photography – Copper spectrum
6. Identification of prominent lines by spectrum photography – Iron spectrum
7. BH loop – Energy loss of a magnetic material – Anchor ring using B.G.
8. Determination of dielectric constant at high frequency by Lecher wire
9. Determination of e/m of an electron by magnetron method
10. Determination of e/m of an electron by Thomson's method
11. Determination of L of a coil by Anderson's method
12. Photoelectric effect (Planck's constant Determination)

B. Electronics Experiments

13. Study of a feedback amplifier – Determination of bank width, input and output impedances.
14. Darlington pair amplifier
15. Design and study of Monostable Multivibrator
16. Design and study of Bistable Multivibrator
17. Design and study of Wein Bridge Oscillator (Op-amp)
18. Design and study of Phase Shift Oscillator (Op-amp)
19. Characteristics of JFET
20. Characteristics of UJT
21. Characteristics of SCR
22. Characteristics of LDR
23. FET amplifier - Common source
24. FET amplifier - Common drain
25. Relaxation oscillator using UJT

SEM: II **HOURS: 5**

PAPER CODE: P2RPHCC5 **CREDIT: 5**

CC - V: ELECTROMAGNETIC THEORY

Objective:

To study the basics of electrostatics and magnetostatics
To understand the wave propagation in different medium.
To acquire the knowledge of EM waves in conductor and dielectric
To study the modes of propagation of guided waves and propagation through wave guides.

Unit I Electrostatics

Coloumbs law-electric intensity-electricpotential-gauss law-dielectrics and its polarization-dielectric constant-types of polarisibility-polarisation of polar and non polar molecules-claussiaus mosotti equation-langevein equations.

Unit II Boundary value problems in electorstatics

Boundary conditions- poisons and laplace equations –method of sepqration of variables in Cartesian coordinates and cylindrical coordinates-method of images (point charge near and infinity ground conducting plane point charge near conducting sphere)-green function method .

Unit III Magnetostatics

Biot savart law-applications(long straight wire and circular coil)-ampere circuital law-applications(long straight wire & solenoid)-force on current carrying conductors(force between two parallel wires and force on a point charge moving in a magnetic field)-hysteresis.

Unit IV Electromagnetic

Faradays law of induction-maxwells diaplacement current- maxwells equations in terms of vector and scalar potentials-gauss transformations –lorentz gauge,coloumb gauge-poyting theorem-conservation of energy and momentum for a sustem of charged particles and electro magnetic fields.

Unit 5: Electromagnetic Waves and Wave Propagation

Propagation of electromagnetic wave in free space – propagation of electromagnetic wave in conducting media (Phase velocity, refractive index, spatial attenuation only) – equation of continuity – displacement current –Wave guides – rectangular wave guide – TM & TE mode.

Books for Study

1.Electromagnetic Theory, Sathyaprakash, kedar nath Ramnath, publishing company meerut, (2006)

2. Classical Electrodynamics J. D. Jackson, (Wiley Eastern Ltd., New Delhi, 1999).

3. Electromagnetic theory, Chopra &Agarwal, K.Nath and Co, Meerut, Sixth edition, 2006.

Books for Reference

1. Introduction to Electrodynamics D. Griffiths, (Prentice-Hall, New Delhi, 1999).

2. The Feynman Lectures on Physics,R. P. Feynman et al, Vol.II (Narosa, New Delhi, 1989).

SEM: II **HOURS: 5**

PAPER CODE: P2RPHCC6 **CREDIT: 5**

CC-VI: QUANTUM MECHANICS

Objectives:

To understand the concepts and Formalism of Quantum Mechanics

To understand the physical application of Schoredinger's equations

To learn approximation methods

To practice Eigen value problems and matrix formulation

To study the concepts of Angular Momentum and Spin States and Relativistic Wave Equations.

Unit 1: Schrödinger Equation and General Formulation

Matter waves - Schrödinger Equation – Physical significance and conditions on the wave function – Expectation values and Ehrenfest's theorem – Hermitian operators and their properties – Commutator relations - Uncertainty relation - Bra and ket vectors - Hilbert space – Schrödinger, Heisenberg and interaction pictures.

Unit 2: Exactly Solvable Systems

One dimensional Schrödinger equation – Particle in a box – Square well potential -- Rectangular barrier potential – Linear harmonic oscillator -Rigid rotator – Hydrogen atom.

Unit 3: Approximation Methods

Time independent perturbation theory: Non-degenerate and degenerate perturbation theories -- Stark effect – WKB Approximation -- Application to tunneling problem and quantization rules.

Time dependent perturbation theory: Harmonic Perturbation -- Transition probability – Fermi –Golden rule .

Unit 4: Scattering Theory and Angular Momentum

Scattering theory: Scattering cross section – Green's function approach -- Born Approximation – Partial wave analysis .

Angular momentum: Matrix Representation of J -- Spin angular momentum -- Eigenvalues -- Addition of angular momenta - Clebsch-Gordan coefficients (J=1 and J=2).

Unit 5: Relativistic Quantum Mechanics

Klein-Gordon equation for a free particle and in an electromagnetic field – Dirac equation for a free particle -- Charge and current densities -- Dirac matrices – Plane wave solution – Negative energy states – Zitterbewegung – Spin angular momentum – Spin-orbit coupling.

Books for Study

1.Quantum Mechanics,V. Devanathan, Naroso Publishing House (2011)

2.Quantum Mechanics, V. K. Thankappan, Wiley-Eastern, Second Edt, New Delhi, (1995).

3. Quantum mechanics, sathya Prakash, Kedarnath Ramnath & Company, Meerut(2006)

Books for Reference

1.Quantum Mechanics, L. Schiff, (Tata McGraw Hill, New Delhi, 1968).

2.A Text Book of Quantum Mechanics P. M. Mathews and K. Venkatesan, (Tata McGraw Hill, New Delhi, 1987).

3.Quantum mechanics, G.Arul dhas, Prientice Hall of India, New Delhi (2006).

SEM: II **HOURS: 5**

PAPER CODE: P2RPHCC7 **CREDIT: 5**

CC-VII : STATISTICALMECHANICS

Objectives:

To review the fundamental concepts of thermodynamics in order to understand Statistical Mechanics.

To acquire knowledge about the phase transition of a system and its models.

To study the kinetic theory of gases and principles of entropy.

To know the concept of Boltzmann transport equation and its applications

To understand the principles of classical statistical mechanic and its application to compute the various parameters of molecules.

To understand the need for quantum Statistical Mechanics and its various applications.

Unit 1: Thermodynamics

Laws of thermodynamics – Some consequences of the laws of thermodynamics – Entropy – Calculation of entropy changes in reversible processes – The principle of increase of entropy – Thermodynamic potentials – chemical potential- Enthalpy, Helmholtz and the Gibbs functions – Phase transitions – The Clausius-Clapeyron equation – Van der Waals equation of state.

Unit 2: Kinetic Theory

Distribution function and its evolution - Boltzmann transport equation and its validity – Boltzmann's H-theorem – Maxwell relation - Chemical potential-Maxwell-Boltzmann distribution - Transport phenomena – Mean free path – Conservation laws

Unit 3: Classical Statistical Mechanics

Review of probability theory – Macro-and micro states – Statistical equilibrium – Phase space and ensembles – Density function – Liouville's theorem.

Maxwell-Boltzmann distribution law – Micro canonical ensemble – Ideal gas – Entropy – Partition function – Principle of equipartition of energy – Canonical and grand canonical ensembles.

Unit 4 : Quantum Statistical Mechanics

Basic concepts – Quantum ideal gas – Bose-Einstein and Fermi-Dirac statistics – Distribution laws – Sackur-Tetrode equation – Equations of state -- Bose-Einstein condensation- Random walk and Brownian motion - Diffusion equation.

Unit 5 : Applications of Q.S.M.

Ideal Bose gas : Principle of detailed balance- Photons – Black body and Planck radiation – Specific heat of solids – Liquid Helium.

Ideal Fermi gas : Properties – Degeneracy – Electron gas – Pauli paramagnetism.

Ferromagnetism : Ising and Heisenberg models.

Books for Study

1. Statistical Mechanics,(K. Huang, Wiley Eastern Limited, New Delhi, 1963).

2. Statistical Mechanics, B. K. Agarwal and M. Eisner, (Wiley Eastern Limited, New Delhi,1994).

3.Thermodynamics, N. Sears and L. Salinger, (Narosa, New Delhi, 1989).

Books for Reference

4. Fundamentals of Statistical and Thermal Physics, F. Reif, (McGraw Hill, Singapore, 1985).

5. Thermodynamics and Statistical Mechnaics, W. Greiner, L. Neise and H. Stocker, (Springer, New York, 1995).

SEM: II **HOURS: 5**

PAPER CODE: P2RPHCC8 **CREDIT: 5**

CC – VIII : ELECTRONICS-II

Micro processor and Micro Controller

Objectives:

To understand the Microprocessor and Microcontroller architecture.

To understand the assembly language program of the micro processor and micro controller.

To understand the hardware components and software programming instructions of INTEL 8086 microprocessors and 8051 microcontroller.

To understand the concept of interfacing and peripheral devices.

Unit 1: 8086Microprocessor Architecture

Organization of 8086 microprocessor-Memory organization - Register structure-Addressing modes in 8086-Pin configuration 8086 microprocessor-Minimum mode configuration-Maximum mode configuration-internal interrupts-External interrupts-Exception handling in 8086

Unit 2:Instruction set and programming(8086)

Data transfer – Arithmetic - Branch Loop - Flag manipulation - Logical shift and rotate instructions. Programme in 8086-Addition – subtraction – multiplication – division - Choosing the biggest and smallest from a list - Arranging a list of numbers in ascending and descending

order. Time delay-Character manipulation.

Unit3:Microcontroller 8051

Overview of 8051 family-pin description of 8051-Registers-Program counter - Romspace-RAM SPACE, Stack, PSW, SFR, Addressing modes-Jump call instruction - Arithmetic and Logic instruction - BIT instruction.

Unit4: Microcontroller SFRS and PROG

Basics of Serial communication-RS232 connections and ICSMAX 232-8051serial communication register - Serial communication programmes – Interrupt - Interrupt reg - Internal and External interrupt programming.

Unit5:Microprocessor and Microcontroller Application

Microprocessor interfacing and application - Programmable Peripheral interface Intel 8255 measurement of frequency, voltage current, measurement of temp, microprocessor based TLC, generate square or pulse.

Micro Controller based Interfacing and application: Interfacing steeper motor, keyboard and DAC.

Books for Study

1. Introduction to Microprocessor 8086 by Aditya P Mathur.
2. Micro Controller and Embedded System by Muhammed Ali Mazidi – 8052

Book for Reference

1. Micro processor 8086 by Raffikuzman.
2. Micro processor and Interfacing by Douglas V. Hall (1998 13th Edition).
3. The 8051 Micro Controller Architecture, Programming & Application (2nd Edition) by Kenneth J ayala.

SEM: II **HOURS: 6**

PAPER CODE: P2RPHCC9P **CREDIT: 5**

CC–IX: PHYSICS PRACTICAL - II

GENERAL EXPERIMENTS

(Any Twleve)

1. Four probe method – Determination of resistivities of powdered samples.
2. Determination of carrier concentration and Hall coefficients in semiconductors.
3. Determination of magnetic susceptibility of liquid by Guoy method.
4. Determination of magnetic susceptibility of liquids by Quincke's method.
5. Determination of dielectric constant of a liquid by RF Oscillator method.
6. Determination of wavelength and thickness of a film by using Michelson's Interferometer.
7. Brass spectrum – Determination of composition.
8. Salt analysis by using Spectrograph.
9. ALO band spectrum.
10. Charge of an electron by spectrometer.
11. Polarizability of liquids by finding the refractive indices at different wavelengths.
12. Determination of wavelength of monochromatic source using Biprism.
13. Determination of refractive index of liquids using Biprism (by scale & telescope method).
14. Determination of specific rotatory power of a liquid using Polarimeter.
15. Rydberg's constant using spectrometer.
16. Determination of coefficient of coupling by AC bridge method.
17. Magneto resistance of powder samples using CE bridge.
18. Forbe's method of determining thermal conductivity.
19. Determination of dielectric loss using CRO.
20. Particle size determination using He-Ne Laser.
21. Laser diode characteristics.

SEM: III **HOURS: 6**

PAPER CODE: P3RPHCC10 **CREDIT: 5**

CC- X: SOLID STATE PHYSICS

Objectives:

To study the structure of crystalline solids

To study the carrier movement, lattice vibration and thermal property in solids

To understand the concepts of Free Electron and Band Theory of Solids

To study the dielectric and magnetism in solids

To study the super conductivity and its applications

UNIT I Crystal Physics

Crystals-Crystal lattice and translation vectors -Types of lattices (2D & 3D)-Point group – Space groups- Lattice direction and planes- Simple crystal structures-Close packed and loose packed structures- Structure of Diamond, Zinc Blende and Sodium chloride- X-ray diffraction-X-ray diffraction methods (Laue's method, Power crystal method)-Reciprocal lattice - #Properties#- Imperfections in crystals- Point defects - line defects.

UNIT-II Semiconductors, Lattice Vibrations and Thermal Property

Intrinsic and Extrinsic semiconductors-General study of carrier movement- Fermi level and conductivity –Lattice vibrations-One dimensional Monotomic lattice-One dimensional diatomic lattice- Phonons- Phonon momentum- Lattice heat capacity- Classical theory (Dulong and Petit Law) - Einstein theory- Debye's model-Density modes.

UNIT-III Free Electron Theory and Band Theory of Solids

Drude - Lorentz's classical theory of free electron gas – Relation between thermal and electrical conductivity (Wiedemann-Franz Law) –Free electron Gas in a 1-D - Free electron Gas in a 3-D- Application of free electron gas model – Bloch theorem –Kronig-Penny model – effective mass of electron.

UNIT-IV Dielectrics and Magnetism in Solids

Polarization and Susceptibility – Local field-Dielectric constant and Polarizability (Clausius-Mosotti Equation) - Sources of Polarizability - Ferro electricity - Piezo electricity. Classical and Quantum theory of Dia and Para magnetism- -Weiss theory of ferromagnetism-Hund rules-Concepts of Domains –Antiferromagnetism-ferrimagnetism

UNIT-V Superconductivity

Introduction –The Meissner effect – Soft and hard superconductors –Thermo dynamical and optical properties – Type -I and Type-II superconductors - London equations – BCS theory-Quantum tunneling-Josephson tunneling- Theory of DC Josephson effect – Theory of AC Josephson effect- High T_C super conductors – SQUIDS – Applications of super conductors

Books for Study

1.Introduction to Solid State Physic, .C. Kittel, (Wiley Eastern, New Delhi, 1977).

2. Solid State Physics, A. J. Dekker, (McMillan, Madras, 1971).

3.Solid State Physics, S. O. Pillai, New Age International (P) Ltd, Revised 6th Edition, 2008.

4.Solid State Physics, Kupta and Kumar, K.Nath & Co, Education Publishers

Books for Rreference

1. An Introduction to X-ray Crystallography, M. M. Woolfson, (Cambridge University Press, Cambridge, 1991).

2. Solid State Physics N. W. Ashcrof and N. D. Mermin, (Holt, Rinehart and Winston, Philadelphia)..

3 Solid State Physics J. S. Blakemore, (Cambridge University Press, Cambridge, 197

SEM: III **HOURS: 6**

PAPER CODE: P3RPHCC11 **CREDIT: 5**

CC XI : ATOMIC ANDMOLECULAR SPECTROSCOPY

Objectives:

To acquire the knowledge of interaction electromagnetic radiation with atoms and molecules and study the different types of spectra

To understand the behavior of the atoms in external fields and quantum chemistry

To know the spectroscopic techniques to used in finding the molecular structure, bond angles, bond length etc.

.

Unit 1 : Atomic Spectra

Quantum states of electron in atoms – Hydrogen atom spectrum – Electron spin – Stern-Gerlach experiment – Spin-orbit interaction – Two electron systems – LS-JJ coupling schemes – Fine structure – Spectroscopic terms and selection rules – Hyperfine structure - Alkali type spectra – Equivalent electrons – Hund's rule

Unit 2: Atoms in External Fields and Quantum Chemistry

Atoms in External Fields : Zeeman and Paschen-Back effect of one and two electron systems -- Selection rules – Stark effect .

Quantum Chemistry of Molecules : Covalent, ionic and van der Waals interactions – Born-Oppenheimer approximation – Heitler-London and molecular orbital theories of H_2 – Bonding and anti-bonding MOs – Huckel's molecular approximation – Application to butadiene and benzene.

Unit 3: Microwave and IR Spectroscopy

Rotational spectra of diatomic molecules – Effect of isotopic substitution – The non-rigid rotor - Rotational spectra of polyatomic molecules – Linear, symmetric top and asymmetric top molecules – Experimental techniques - Vibrating diatomic molecule – Diatomic vibrating rotator – Analysis by infrared techniques – Characteristic and group frequencies

Unit 4: Raman Spectroscopy and Electronic Spectroscopy of Molecules

Raman spectroscopy : Raman effect - Quantum theory of Raman effect – Rotational and vibrational Raman shifts of diatomic molecules – Selection rules.

Electronic spectroscopy of molecules : Electronic spectra of diatomic molecules -- The Franck-Condon principle – Dissociation energy and dissociation products – Rotational fine structure of electronic vibration transitions

Unit 5: Resonance Spectroscopy

NMR: Basic principles –Bloch equations - Chemical Shift – Relaxation process – Instrumentation: Fourier transform method – NMR Imaging.

ESR: Basic Principles – Nuclear interaction and hyperfine structure –'g' characteristics – ESR Spectrometer.

Books for Study

1. Fundamentals of Molecular Spectroscopy, C. N. Banwell, (McGraw Hill, New York, 1981).
2. Spectroscopy Vol.I.,B. P. Straughan and S. Walker, (Chapman and Hall, New York, 1976).
3. The Feynman Lectures on Physics Vol. III. R. P. Feynman et al. (Narosa, New Delhi, 1989).
4. Introduction to Modern Physics H. S. Mani and G. K. Mehta, (Affiliated East West, New Delhi,1991).
5. Introductory Quantum Chemistry,A. K. Chandra, (Tata McGraw Hill, New Delhi, 1989).

Books for Reference

1. High Resolution NMR, Pople, Schneiduer and Berstein, (McGraw Hill, New York).
2. Atomic Stucture and Chemical Bond, Manas Chanda, (Tata McGraw Hill, New Delhi, 1991).
3. Quantum Chemistry, Ira N. Levine, (Prentice-Hall, New Delhi, 1994).
4. Concepts of Modern Physics, Arthur Beiser, (McGraw Hill, New York, 1995).
5. Principles of Magnetic Resonance, C.P. Slitcher, (Harper and Row).

SEM: IV **HOURS: 3**

PAPER CODE: P4RPHCC12P **CREDIT: 5**

CC XII : PHYSICS PRACTICAL - III

(ADVANCED ELECTRONICS LAB)

Any Fifteen only

1. Logic gates – Universality of NAND gates Using IC's
2. Logic gates – Universality of NOR gates Using IC's
3. Verification of Demorgans theorems and Boolean Expressions
4. Astable and bistable and monostable multivibrator using IC 555
5. Phase shift network and Oscillator using IC 741
6. Wien's bridge oscillator using IC 741

7. Construction of dual regulated power supply
8. Half and Full wave precision rectifier using IC 741
9. Characteristics of LVDT
10. Study of the characteristics of torque transducer
11. Digital to analog converter - R-2R method and Weighted method
12. Study the function of multiplexer and demultiplexer
13. Study the function of decoder and encoder
14. Flip flops
15. Half adder and Full adder (using only NAND & NOR gates)
16. Half subtractor and Full Subtractor (using only NAND & NOR gates)
17. Digital comparator using XOR and NAND gates
18. BCD to seven segment display
19. Study of counter using IC 7490 (0-9 and 00-99)
20. Measurement of Resistance using AC Wheatstone bridge

SEM: IV **HOURS: 3**

PAPER CODE: P4RPHCC13P **CREDIT: 5**

CC - XIII: PHYSICS PRACTICAL – IV –

(MICROPROCESSORS 8086)

(Any fifteen only)

1. 8 bit addition, subtraction, multiplication and division using 8085/Z80.
2. 16 bit addition, 2's complement and 1's complement subtraction (8086/8088).
3. Conversion from decimal to octal and hexa systems.
4. Conversion from Octal, Hexa to Decimal systems.
5. Sum of series
6. Data transfer
7. Table of square
8 ASCII to decimal conversion
9. Decimal to ASCII conversion
10. Display of names

11. Interfacing Hexa key board (IC 8212).
12. Study of Seven Segment Display
13. Study of DAC interfacing (DAC 0900).
14. Study of ADC interfacing (ADC 0809).
15. Study of timer interfacing (IC 8253).
16. Study of programmable interrupt controller (IC 8259).
17. Traffic control system using microprocessor.
18. Microprocessor as digital clock.
19. Generation of square, triangular, saw-tooth staircase and sine waves using DAC 0800.
20. Microprocessor as digital thermometer (temperature controller).
21. Control of stepper motor using microprocessor.

SEM: IV **HOURS: 6**

PAPER CODE: P4RPHCC14 **CREDIT: 5**

CC XIV : NUCLEAR AND PARTICLE PHYSICS

Objectives:

To understand the basic structure and properties of the nucleus.

To differentiate different types of nuclear reactions and nuclear models

To know the causes and mechanism of natural radioactivity.

To understand the fission, fusion energy and reactors

To study about the properties of elementary particles

Unit 1 : Basic Nuclear Properties:

Nuclear size, shape, mass – Charge distribution – Spin and parity – Binding energy – Semi empirical mass formula – Nuclear stability – Mass parabola -- Nature of nuclear forces – Ground state of deuteron – Magnetic dipole moment of deuteron – Proton-neutron scattering at low energies – Scattering length, phase shift – Properties of nuclear forces – Spin dependence – Exchange forces**.**

Unit 2 : Nuclear Reactions and Nuclear Models:

Q-values and kinematics of nuclear cross sections – Energy and angular dependence – Reciprocity theorem – Breit-Wigner formula – Compound nucleus – Resonance theory – Optical model -- Shell model – Liquid drop model – Collective model.

Unit 3 : Radioactive Decays and reactors:

Alpha emission – Geiger-Nuttal law – Gamow theory – Neutrino hypothesis – Fermi theory of beta decay – Selection rules – Non conservation of parity – Gamma emission – Selection rules - Interaction of charged particles and X-rays with matter – Basic principles of particle detectors – Ionization chamber – Proportional counter and G.M counters – Solid state detectors – Scintillation and semiconductor detectors.

Unit 4: Accelerators and particle detectors:

Cyclotron – Synchrocyclotron – Synchrotron – Linear accelerators --Characteristics of fission – Mass distribution of fragments – Radioactive decay processes – Fission cross section – Energy in fission – Bohr-Wheeler's theory of nuclear fission – Fission reactors – Thermal reactors – Homogeneous reactors – Basic fusion processes - Characteristics of fusion – Solar fusion – Controlled fusion .

Unit 5 : Elementary Particles:

Building blocks of nucleus – Nucleons, leptons, mesons, baryons, hyperons, hadrons, strange particles - Classification of fundamental forces and elementary particles – Basic Conservation laws – Additional Conservation laws : Baryonic, leptonic, strangeness and iso spin charges/quantum numbers — Gell-Mann-Nishijima formula –TCP theorem -- Parity non conservation in weak interactions – CP violation — SU(3) symmetry and quark model

Books for Study

1. Introductory Nuclear Physics, K. S. Krane, (John-Wiley, New York, 1987).
2. Nuclear Physics, V. Devanathan, Naroso Publishing House (2006)
2. Nuclear Physics: An Introduction, S. B. Patel, (Wiley-Eastern, New Delhi, 1991).
3. Concepts of Nuclear Physics, B. L. Cohen, (Tata McGraw Hill, New Delhi, 1988).

4.Nuclear and Particle Physics , D.G. Dhayal

Books for Reference:

1. Nuclear Physics: Experimental and Theoretical, H. S. Hans, (New Age International Publishers, New Delhi, 2001).
2. Elementary Particle Physics: An Introduction, D. C. Cheng and G. K. O'Neill, (Addison-Wesley, 1979).
3. Introduction to Elementary Particles, D. Griffiths, Introduction to Elementary Particles (Wiley International, New York, 1987).

SEM: IV **HOURS: 18**

PAPER CODE: P4RPHCC15PW **CREDIT: 8**

CC XV: PROJECT WORK

Elective Course papers:

SEM: I **HOURS: 6**

PAPER CODE: P1RPHEC1 **CREDIT: 3**

EC – I : NUMERICAL METHODS AND COMPUTATIONAL PHYSICS

Objectives:

To understand the numerical computations for algebraic, transcendental and linear simultaneous equations.

To understand the concept of linear interpolation and curve fitting.

To understand the numerical differentiation and integration.

Unit 1: Errors and the measurements

General formula for errors – Errors of observation and measurement – Empirical formula – Graphical method – Method of averages – Least square fitting – curve fitting – parabola,

exponential.

Unit 2: Numerical solution of algebraic and transcendental equations

The iteration method – The method of false position – Newton – Raphson method – Convergence and rate of convergence – C program for finding roots using Newton – Raphson method. Simultaneous linear algebraic equations - Gauss elimination method – Jordon's modification – Gauss–Seidel method of iteration – C program for solution of linear equations.

Unit 3: Interpolation

Linear interpolation – Lagrange interpolation Gregory – Newton forward and backward interpolation formula – Central difference interpolation formula – Gauss forward and backward interpolation formula – Divided differences – Properties – Newton's interpolation formula for unequal intervals – C programming for Lagrange's interpolation.

Unit 4: Numerical differentiation and integration

Newton's forward and backward difference formula to compute derivatives – Numerical integration : the trapezoidal rule, Simpson's rule – Extended Simpson's rule – C program to evaluate integrals using Simpson's and trapezoidal rules.

Unit 5: Numerical Solutions of ordinary differential equations

N^{th} order ordinary differential equations – Power series approximation – Pointwise method – Solutions of Taylor series – Euler's method – Improved Euler's method – Runge-Kutta method – second and fourth order — C program for solving ordinary differential equations using RK and Eulers method.

Books for study

1. Introductory Methods of Numerical analysis – S.S. Sastry, Prentice – Hall of India, New Delhi (2003) 3^{rd} Edition.
2. Numerical Methods in Science and Engineering – The National Publishing Co. Madras (2001).
3. Numerical Methods in C and C++, Veerarajan, S.Chand, New Delhi (2006).

Books for Reference :

1. Numerical Recipes in C, W.H. Press, B.P.Flannery, S.A.Teukolsky, W.T. Vetterling, Cambridge University (1996).
2. Monte Carlo : Basics, K.P.N. Murthy, ISRP, Kalpakkam, 2000.

SEM: II **HOURS: 4**

PAPER CODE: P2RPHCC10 **CREDIT: 3**

EC II : Crystal Growth and Thin Films

Objectives:

To learn the crystal growth and characterization techniques

To study the formation of thin film and its analysis

Unit 1 : Nucleation and Crystal Growth

Nucleation – Different kinds of nucleation - Concept of formation of critical nucleus – Classical theory of nucleation - Spherical and cylindrical nucleus - Low temperature solution growth: Solution - Solubility and super solubility – Expression of super saturation – Miers T-C diagram - Growth Kinetics of Thin Films – Thin Film Structure – Crystal System and Symmetry.

Unit 2 : Gel and Solution Growth Techniques

Constant temperature bath and crystallizer – Seed preparation and mounting - Slow cooling and solvent evaporation methods.

Principle – Various types – Structure of gel – Importance of gel – Experimental procedure – Chemical reaction method – Single and double diffusion method – Chemical reduction method – Complex and decomplexion method – Advantages of gel method.

Unit 3 : Melt and Vapour Growth Techniques

Melt technique:

Bridgman technique - Basic process – Various crucibles design - Thermal consideration – Vertical Bridgman technique - Czochralski technique – Experimental arrangement – Growthprocess.

Vapour technique:

Physical vapour deposition – Chemical vapour deposition (CVD) – Chemical Vapour Transport.

Unit 4 : Thin Film Deposition Techniques

Thin Films – Introduction to Vacuum Technology - Deposition Techniques - Physical Methods – Resistive Heating, Electron Beam Gun, Laser Gun Evaporation and Flash Evaporations,Sputtering - Reactive Sputtering, Radio-Frequency Sputtering - Chemical Methods – Spray Pyrolysis – Preparation of Transparent Conducting Oxides.

Unit 5 : Characterization Technique

X – Ray Diffraction (XRD) – Powder and single crystal - Fourier transform Infrared analysis (FT-IR) – Elemental analysis – Elemental dispersive X-ray analysis (EDAX) - Scanning Electron Microscopy (SEM) – UV-Vis-NIR Spectrometer – Etching (Chemical) – Vickers Micro hardness.

Books for Study

1. Crystal Growth Processes and Methods, P. SanthanaRagavan and P. Ramasamy, KRU Publications, Kumbakonam (2001)

2. Thin Film Fundamentals, A. Goswami, New Age International (P) Limited, New Delhi (1996)

Books for Reference

1.Crystal Growth Processes, J.C. Brice, John Wiley and Sons, New York (1986)

2.H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, CBS, Publishers and Distributors, New Delhi

SEM: III **HOURS: 6**

PAPER CODE: P3RPHEC3 **CREDIT: 3**

EC III : NANOSCIENCE AND NANOTECHNOLOGY

Objectives:

To learn the nano technology and nano materials

To study the application of nano materials in medicine

To understand Evaluation techniques and Green technology

Unit 1: Background to nanotechnology

Scientific revolution- Atomic structures-Molecular and atomic size-Bohr radius – Emergence of Nanotechnology – Challenges in Nanotechnology - Carbon age–New form of carbon. (from Graphene sheet to CNT)

Unit 2: Nucleation

Influence of nucleation rate on the size of the crystals- macroscopic to microscopic crystals and nanocrystals - large surface to volume ratio, top-down and bottom-up approaches-self assembly process-grain boundary volume in nanocrystals-defects in nanocrystals-surface effects on the properties.

Unit 3: Types of Nanostructures

Definition of a Nano system - Types of Nanocrystals-One Dimensional (1D)-Two Dimensional (2D) -Three Dimensional (3D) nanostructured materials - Quantum dots - Quantum wire-Core/Shell structures.

Unit 4: Nanomaterials and properties

Carbon Nanotubes (CNT) - Metals (Au, Ag) - Metal oxides (TiO_2, ZnO) - Semiconductors (Si, Ge,) - Ceramics and Composites - Dilute magnetic semiconductor-Biological system - DNA and RNA - Lipids - Size dependent properties - Mechanical, Physical and Chemical properties.

Unit 5: Applications of Nanomaterials

Molecular electronics and nanoelectronics – Quantum electronic devices - CNT based transistor and Field Emission Display - Biological applications - Biochemical sensor - Membrane based water purification.

Book for Study

1. Nanotechnology: Basic science and Emerging technologies, M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.
2. The chemistry of nanomaterials: Synthesis, properties and applications, C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.
3. Nanoscale Materials Science, Kenneth J. Klabunde (Eds), John Wiley & Sons, InC, 2001.
4. Nanofabrication towards biomedical applications, C.S.S.R.Kumar, J.Hormes, C.Leuschner, –VCH Verlag GmbH & Co, Weinheim, 2004.

Books for Reference

1. Nano Electronics and information Technology,W. Rainer, Wiley, 2003.
2. Nano systems, K.E.Drexler, Wiley, 1992.
3. Naostructures and Nanomaterials: Synthesis, properties and applications,G.Cao, Imperical College Press, 2004.

SEM: III **HOURS: 6**

PAPER CODE: P3RPHEC4 **CREDIT: 3**

EC IV: NONLINEAR OPTICS

Objectives

To understand the different types of Lasers.

To study the different harmonic generations

To study the Fiber optical communication systems.

To study the Non linear optical materials.

Unit 1: Lasers:

Gas lasers – He-Ne, A_{Z+}^{ion} lasers – Solid state lasers – Ruby – Nd- YAG, Ti Sapphire – Organic dye laser – Rhoda mine – Semiconductor lasers – Diode laser, Ga-As laser

Unit 2: Fiber Optics

Step – Graded index fibers – wave propagation – Fiber modes – Single and multimode fibers – Numerical aperture – Dispersion – Fiber bandwidth – Fiber loss – Attenuation coefficient – Material absorption.

Unit 3: Introduction to Nonlinear Optics

Wave propagation in an anisotropic crystal – Polarization response of materials to light – Harmonic generation – Second harmonic generation – Sum and difference frequency generation – Phase matching – Third harmonic generation – disability – self focusing

Unit 4: Multiphoton Processes

Two photon process – Theory and experiment – Three photon process Parametric generation of light – Oscillator – Amplifier – Stimulated Raman scattering – Intensity dependent refractive index optical Kerr effect – photorefractive, electron optic effects

Unit 5: Nonlinear Optical Materials

Basic requirements – In organics – Borates – Organics – Urea, Nitro aniline – Semi organics – Thio urea complex – X-ray diffraction – FT-IR - FT-NMR- Second harmonic generation – Laser induced surface damage threshold.

Books for Study

1. Nonlinear Optics,,Robert W. Boyd, 2nd Edn., Academic Press, New York, 2003
2. Laser Fundamentals, William T. Silvast, Cambridge University Press, Cambridge 2003

Books for Reference

1. Lasers and Nonlinear Optics,B.B. Laud, 2nd Edn. New Age International (P) Ltd., New Delhi, 1991
2. Fiber-Optics Communication Systems, Govind P. Agarwal, , 3rd Edn. John Wiley & Sons, Singapore 2003
3. Nonlinear Optics – Basic Concepts D.L. Mills, Springer, Berlin 1998.

SEM: III **HOURS: 6**

PAPER CODE: P3RPHCC10 **CREDIT: 5**

EC V: Medical Physics

Objectives:

To acquire knowledge of forces, pressure and the importance of temperature in human body.

To understand the physics principles involved in respiration and cardiovascular system.

To understand how electric signals generate in human body and the working of EMG and ECG.

To understand the application of sound and light in medicine and medical imaging.

To understand the use of X – rays and radioactivity for diagnosis and treatment.

Unit I: Mechanics of Human Body

Static, Dynamic and Frictional forces in the Body – Composition, properties and functions of Bone – Heat and Temperature – Temperature scales – Clinical thermometer – Thermography – Heat therapy – Cryogenics in medicine – Heatlosses from Body – Pressure in the Body – Pressure in skull, Eye and Urinary Bladder.

Unit II: Physics of Respiratory and Cardiovascular System

Body as a machine – Airways – Blood and Lungs interactions – Measurement of Lung volume – Structure and Physics of Alveoli – Breathing mechanism – Airway resistance – Components and functions of Cardiovascular systems –work done by Heart – Components and flow of Blood – Laminar and Turbulent flow – blood Pressure – direct and indirect method of measuring –Heart sounds.

Unit III: Electricity in the Body

Nervous system and Neuron – Electrical potentials of Nerves – Electric signals from Muscles, Eye and Heart – Block diagram and working to record EMG - Normal ECG wave form – Electrodes for

ECG – Amplifier and Recording device – Block diagram and working to record ECG – Patient monitoring – Pace maker.

Unit IV: Sound and Light in Medicine

General properties of sound – Stethoscope - Generation, detection and characteristics of Ultrasound –Ultrasound imaging technique – A scan and B scan methods of ultrasound imaging – properties of light – Applications of visible UV, IR light, and Lasers in medicine – Microscope – Eye as an optical system – Elements of the Eye – Ophthalmology Instruments.

Unit V: Diagnostic X-Rays and Nuclear Medicine

Production and properties of X-rays – Basic Diagnostic X-ray Machine – X-ray image – Live X-ray image – X-ray computed Tomography – Characteristics of Radio activity – Radioisotopes and Radio nuclides – Radioactivity sources for Nuclear medicine – Basic Instrumentation and clinical applications – Principles of Radiation Therapy – Nuclear medicine imaging devices – Radiation sources

Books for Study

1.

2.

Books for Reference

1.Medical Physics, John R. Cameron and James G. Skofronick, John Wiley & SonsWiley – Interscience Publications, 1978.

2. Hand book of Biomedical Instrumentation, R.S.Khandpur - Tata McGraw Hill Publication Co., Delhi, 1987.

****