DEPARTMENT OF STUDIES AND RESEARCH IN PHYSICS

M.Sc. in Physics

Course Structure & Syllabus

Choice Based Credit System (CBCS)

2023-24

Chairman, BOS in Physics

SEMESTER-I

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Exam.	Total
1	CPT 1.1	Classical Mechanics	4	4	3 Hrs	30	70	100
2	CPT 1.2	Mathematical and Computational Physics	4	4	3 Hrs	30	70	100
3	CPT 1.3	Electronics Devices, Communication and Transducers	4	4	3 Hrs	30	70	100
4	SPT 1.4 A	Condensed Matter Physics- I (Special)	4	4	3 Hrs	30	70	100
	SPT 1.4 B	Material Science-I (Special)	4	4	3 Hrs	30	70	100
5	CPP 1.5	**Practical:** General Physics	4	2	4 Hrs	15	35	50
6	CPP 1.6	**Practical:** Computer Programming-I	4	2	4 Hrs	15	35	50
7	CPP 1.7	**Practical:** Electronics (General)	4	2	4 Hrs	15	35	50
8	SPP 1.8 A	**Practical:** Condensed Matter Physics-I (Special)	4	2	4 Hrs	15	35	50
	SPP 1.8 B	**Practical:** Material Science-I (Special)	4	2	4 Hrs	15	35	50
TOTAL			**32**	**24**				**600**

***NOTE*: Theory: 1 Hr=1Credit; Practicals: 2Hrs=1Credit**

CPT: Core Paper Theory

CPP: Core Paper Practical

SPT: Special Paper Theory

SPP: Special Paper Practical

SEMESTER-II

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Exam.	Total
1	CPT 2.1	Quantum Mechanics-I	4	4	3 Hrs	30	70	100
2	CPT 2.2	Statistical Mechanics	4	4	3 Hrs	30	70	100
3	SPT 2.3 A	Condensed Matter Physics- II (Special)	4	4	3 Hrs	30	70	100
	SPT 2.3 B	Material Science-II (Special)	4	4	3 Hrs	30	70	100
4	OET 2.4	Modern Physics	4	4	3 Hrs	30	70	100
5	CPP 2.5	**Practical:** Modern Physics-I	4	2	4 Hrs	10	40	50
6	CPP 2.6	**Practical:** Computer Programming-II	4	2	4 Hrs	15	35	50
7	SPP 2.7 A	**Practical:** Condensed Matter Physics-II (Special)	4	2	4 Hrs	15	35	50
	SPP 2.7 B	**Practical:** Material Science-II (Special)	4	2	4 Hrs	15	35	50
8	OEP 2.8	**Practical:** Modern Physics	4	2	4 Hrs	15	35	50
TOTAL			**32**	**24**				**600**

***NOTE*: Theory: 1 Hr=1Credit; Practicals: 2Hrs=1Credit**

CPT: Core Paper Theory

CPP: Core Paper Practical

SPT: Special Paper Theory

SPP: Special Paper Practical

OET: Open Elective Theory

OEP: Open Elective practical

Chairman, BOS in Physics

SEMESTER-III

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Exam.	Total
1	CPT 3.1	Quantum Mechanics-II	4	4	3 Hrs	30	70	100
2	CPT 3.2	Nuclear Physics	4	4	3 Hrs	30	70	100
3	SPT 3.3 A	Condensed Matter Physics- III (Special)	4	4	3 Hrs	30	70	100
	SPT 3.3 B	Material Science-III (Special)	4	4	3 Hrs	30	70	100
4	OET 3.4	Nanoscience and Nanotechnology	4	4	3 Hrs	30	70	100
5	CPP 3.5	**Practical:** Modern Physics-II	4	2	4 Hrs	15	35	50
6	CPP 3.6	**Practical:** Nuclear Physics	4	2	4 Hrs	15	35	50
7	SPP 3.7 A	**Practical:** Condensed Matter Physics-III (Special)	4	2	4 Hrs	15	35	50
	SPP 3.7 B	**Practical:** Material Science-III (Special)	4	2	4 Hrs	15	35	50
8	OEP 3.8	**Practical:** Nanoscience and Nanotechnology	4	2	4 Hrs	15	35	50
TOTAL			**32**	**24**				**600**

***NOTE*: Theory: 1 Hr=1Credit; Practicals: 2Hrs=1Credit**

CPT: Core Paper Theory

CPP: Core Paper Practical

SPT: Special Paper Theory

SPP: Special Paper Practical

OET: Open Elective Theory

OEP: Open Elective practical

Chairman, BOS in Physics

SEMESTER-IV

Sl. No.	Paper	Title of the paper	Instruction Hrs per Week	No. of Credits	Duration of the Exam.	Marks		
						Internal Assessment	Semester End Exam.	Total
1	CPT 4.1	Classical Electrodynamics	4	4	3 Hrs	30	70	100
2	CPT 4.2	Atomic, Molecular and Optical Physics	4	4	3 Hrs	30	70	100
3	SPT 4.3 A	Condensed Matter Physics- IV (Special)	4	4	3 Hrs	30	70	100
	SPT 4.3 B	Material Science-IV (Special)	4	4	3 Hrs	30	70	100
4	CPP 4.4	**Practical:** Modern Physics-III	4	2	4 Hrs	15	35	50
5	CPP 4.5	**Practical:** Atomic, Molecular and Optical Physics	4	2	4 Hrs	15	35	50
6	SPP 4.6 A	**Practical:** Condensed Matter Physics-IV (Special)	4	2	4 Hrs	15	35	50
	SPP 4.6 B	**Practical:** Material Science-IV (Special)	4	2	4 Hrs	15	35	50
7	Project 4.7		8 (4+4)	6	4 Hrs	15+30	Viva-Voce 35 Dissertation 70	150
TOTAL			**32**	**24**				**600**

***NOTE*: Theory: 1 Hr=1Credit; Practicals: 2Hrs=1Credit**

CPT: Core Paper Theory

CPP: Core Paper Practical

SPT: Special Paper Theory

SPP: Special Paper Practical

Chairman, BOS in Physics

INTERNAL ASSESSMENT, SEMINAR, AND EXTRA ACTIVITIES

Internal Assessment Marks allotment:

1st Test:	20 marks
2nd Test:	20 marks
Average of two tests:	20 marks
Seminar and assignments:	5 marks
Extra activities:	5 marks
(Awareness programmes and extension activities etc...)	
TOTAL:	30 marks

Chairman, BOS in Physics

SEMESTER-I

CPT 1.1: CLASSICAL MECHANICS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Lagrangian Mechanics: Generalized coordinates, constraints, D'Alembert's principle of virtual work and Lagrange equations of second kind. Examples of Lagrangian formalism. Hamilton's principle, Derivation of Lagrange's equation from Hamilton's Principle. Symmetry and conservation laws: momentum conservation, cyclic co-ordinates.

Motion in central force field: Equivalent one body problem, motion in central force field, Conservation of angular momentum and energy, Equation of orbit. Elliptic orbits, hyperbolic orbits and parabolic orbits. Elastic scattering in central force field, Rutherford scattering,

12 hrs

UNIT 2

Motion of Rigid body: Degrees of freedom of a free rigid body, Angular momentum and kinetic energy of rigid body. Fixed and moving coordinate systems. Coriolis force, Coriolis force acting on falling body, Euler theorem. Euler angle, Angular momentum and kinetic energy of a rigid body. Inertia tensor, Euler's equations of motion. Torque free motion. Precession of earth's axis of rotation, motion of symmetrical top: rotational motion.

12 hrs

UNIT 3

Hamilton's equations: Generalized momenta. Hamilton's equations. Examples (i) the simple harmonic oscillator. (ii) Hamiltonian for a free particle in different coordinate system. Cyclic coordinates. Physical significance of the Hamiltonian function. Derivation of Hamilton's equations from a variational principle. Generating functions (Four basic types), examples of Canonical transformations, Poisson brackets; properties of Poisson brackets, angular momentum and Poisson bracket relations. Equation of motion in the Poisson bracket notation. The Hamilton-Jacobi equation; the example of the harmonic oscillator treated by the Hamilton-Jacobi method.

12 hrs

UNIT 4

Small oscillations: Eigen value equation, frequencies of free vibration, normal coordinates, free vibrations of linear triatomic molecule.

Relativistic Mechanics. Principles of special theory of relativity, Lorentz transformations, Velocity addition and Doppler effect. Relativistic mechanics: Four-dimensional formulation-fourvectors, four-velocity, four-momentum and four-acceleration. Lorentz co-variant form of equation of motion.

12 hrs

REFERENCES:

1. Classical mechanics, H. Goldstein, C. Poole, J. saflco. 3rd edition. Pearson Education inc.
2. Classical mechanics. K. N. Srinivasa Rao, University press
3. Classical mechanics, N. C. Rana and P.S. Joag Tata McGraw-Hill
4. Classical dynamics of particles and systems, J. B. Marion, Academic press
5. Introduction to Classical mechanics. Takwale and Puranik, Tata McGraw-hill
6. Classical mechanics, L. D. Landau and E. M. Lifshitz, 4thedition, Pergamon Press
7. S.L. Gupta, V. Kumar and H.V. Sharma, Classical Mechanics (Pragati Prakashan, Meerut
8. Discrete mechanics: Concepts and applications, Jean-Paul Caltagirone, 1st edition, Wiley-ISTE

CPT 1.2: MATHEMATICAL AND COMPUTATIONAL PHYSICS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Vector Analysis: Gradient of scalar field, Divergence and curl of a vector field, Vector integration, Gauss, Stokes and Green's theorem.
Linear vector space: Linear dependence and independence, Dimension, Basis, Change of basis, Subspace, Isomorphism, Linear operators.
Matrices: Orthogonal, Hermitian, and unitary matrices, Cayley-Hamilton Theorem, eigenvectors and eigenvalues, diagonalization of matrices.
Tensors: Contravariant and covariant tensors, symmetric and anti-symmetric tensors, Tensor algebra, Outer product, Contraction of indices, Inner product

12 hrs

UNIT 2

Ordinary Differential equations: First and second order homogeneous and non-homogeneous equations with constant and variable coefficients.
Special functions: Power series method for ordinary differential equations, Legendre polynomials, Rodrigue's formula; generating function and recursion relations, Hermite functions: Hermite polynomials, generating function, recursion relations; Orthogonality, Laguerre functions: Lauguerre polynomials, recursion relations; Orthogonality.

12 hrs

UNIT 3

Gamma function and Beta function: definition, simple properties.

Numerical techniques and Numerical methods:
Solutions of algebraic and transcendental questions: Bisection, iterative and Newton-Raphson methods. Interpolation: Newton's and Lagrange's methods. Curve fitting: method of least squares. Differentiation: Newton's formula, Integration: Trapezoidal rule, Simpson's 1/3 and 3/8 rules, solutions of ordinary differential equations: Euler's modified method and Runge-Kutta method.

12 hrs

UNIT 4

C-Language and Programming: Constants and variables, arithmetic expressions, data types, input and output statements, control statements, switch statements, the loop statements, format specifications, functions.
Examples for programming in C: Solutions of algebraic equations-quadratic and higher order equations, linear least square fit, Newton's forward and backward interpolation formulae, numerical integration - Trapezoidal rule, Simpson's1/3 and 3/8 rules, numerical differentiation-Euler's modified method, Runge Kutta 2nd and 4th order methods, Eigen values and eigen vectors of a matrix, Solutions of ordinary differential equations.

12 hrs

REFERENCES:

1. Mathematical Physics, Chattopadhyaya P.K, Wiley Eastern
2. Vector Analysis, Murray R Spiegel, Schaum's Outline Series, McGraw Hill International Book Company, Singapore
3. Introduction to Mathematical Physics, Charlie Harper, Prentice-Hall of India Private Limited, New Delhi
4. Programming in ANSI C, Balaguruswamy E, Tata McGraw Hill
5. C Language And Numerical Methods, New Age International (P) Limited Publishers, New Delhi

CPT 1.3: ELECTRONIC DEVICES, COMMUNICATION AND TRANSDUCERS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Transistors: Review of Biasing, Applications of Transistors: small signal single stage and multistage amplifier, Push-pull amplifier, Multivibrators: Astable and Bistable, Oscillators: Colpitts and Hartley oscillator, Voltage regulator.

Operational Amplifier: Parameters of an op-amp, Applications: Voltage to current converter, Current to voltage converter, Instrumentation amplifier, Logarithmic and exponential amplifiers, Comparators, Square wave, Sine wave and triangle wave generator, Schmitt trigger, Active filters- First order Butterworth low pass and high pass filter.

12 hrs

UNIT 2

Optoelectronic Devices: Principle, working and characteristics of LDR, photodiode, LED, Phototransistor and semiconductor laser.

Radio Communication: Principle of AM and FM, Block diagrams of AM and FM transmitters, Principle of AM and FM demodulation, Comparison of AM and FM, Principle and block diagram of super heterodyne receiver.

Optical Fibre Communication: The general system, Advantages of OFC, Optical fibre wave guide, Theory of transmission: total internal reflection, acceptance angle, numerical aperture.

12 hrs

UNIT 3

Digital Fundamentals: Review of logic gates. Simplification of Boolean expression: SOP and POS. Karnaugh map: two, three and four variable map.

Sequential circuits: Latches, SR-Flip-flop, JK- Flip-flop, JK Master-Slave, D- flip-flop and T- flip-flop, Counters: synchronous and asynchronous counters, ripple counters, Shift registers.

A/D and D/A converters: Introduction, filtering and sampling, quantization, quantization error, Binary weighted and R-2R ladder D/A converter, Successive –approximation A/D converter.

12 hrs

UNIT 4

Transducers: Classification of transducers, Characteristics of transducers, Resistive transducers, Srain gauges, Resistance thermometer, Magnetic thermometer, Basics of inductive and capacitive transducers.

Signals: Continuous time signals, Discrete time signals, Periodic signals, Representation of signals, Operations on signals, Fourier transforms of some useful functions, Properties, Signal averaging, lock-in detector, box-car integrator.

Basics of microprocessor: Architecture of 8085, addressing modes, Instruction set, pin diagram, Memory organization.

Basics of microcontroller: Architecture of 8051, Pin description, Memory organization, Instruction set, Interfacing and applications: Interfacing of 7-segment LED and digital thermometer.

12 hrs

REFERENCES:

1. Basic Electronics and Linear Circuits, NN Bhargava, DC Kulashreshtha and SC Gupta, Tata Mc Graw Hill
2. Electronic Devices and Circuits: An Introduction, Allen Mottershead, Prentice Hall of India
3. Electronic Devices and Circuits, Devid A Bell, Oxford University Press, New York
4. Semiconductor Optoelectronic Devices, Pallab Bhattacharya, Pearson education

5. A Text Book of Basic Electronics, R S Sedha, S Chand & Company Ltd.
6. Op-Amps and Linear Integrated Circuits, Remakant A Gayakwad, Eastern Economy Edition
7. Linear Integrated Circuits, D Roy Choudhury and Shail Jain, New Age International Limited
8. Electronic Communication Systems, George Kennedy and Bernard Davis, Tata McGraw Hill Education
9. Optical fibre Communication, Gerd Keiser, Tata McGraw Hill
10. Handbook of Optoelectronics: Enabling Technologies (Volume I), John P. Dakin, Robert G. W. Brown, Taylor & Francis (CRC Press)
11. Digital Fundamentals, Floyd and Jain, Pearson Education
12. Modern Digital and Analog Communication Systems, B. P. Lathi, Zhi Ding, Oxford University Press, New York
13. Sensors and Tranducers, D Patranabis, Prentice-Hall of India Private Limited, New Delhi
14. Fundamentals of Microprocessors and Microcontrollers, B Ram, Dhanpat Rai Publications
15. 8051 Microcontroller: Hardware, Software and Applications, V. Udayashankara and M. S Mallikarjuna swamy, Tata McGraw Hill
16. The 8051 Microcontroller and Embedded Systems Using Assembly and C, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, Second Edition, Pearson Education India

SPT 1.4 A: CONDENSED MATTER PHYSICS-I (SPECIAL)

Teaching Hrs per week: 4hrs

Total Hrs: 48hrs

UNIT 1

Crystal structure: Lattice and basis, Unit cell and Primitive cell, Wigner-Seitz Primitive cell, non-primitive cells, Lattice translational vectors, Seven crystal systems and Fourteen Barvais lattice with examples of simple crystal structures. Symmetry in crystals, symmetry elements, Coupling and combination of symmetry elements. Point groups, Space group: notations and analysis, Miller indices and interplanar distances.

12 hrs

UNIT 2

Crystal binding: Crystals of inert gases, Van der Waals-London interaction, Repulsive interaction, Cohesive energy.

Ionic Crystals: Madelung energy, Born Mayer Model, Evaluation of Madelung constant for an infinite line of ions. Covalent crystals, metals, Hydrogen bond.

Lattice vibrations and thermal properties: Elastic waves, density of states of a continuous medium, Theories of specific heat: Classical, Einstein and Debye models. Vibration of one dimensional monatomic and diatomic lattice, properties of lattice waves, phonons. Lattice thermal conductivity.

12 hrs

UNIT 3

Free electron model of metals: Drude model, Electrical conductivity of metals, Thermal conductivity of metals, Lorentz modification of the Drude model, Fermi Dirac distribution function, Sommerfeld model, The density of states, Free electron gas at 0K, Energy of electron gas at 0K, Electron heat capacity, Sommerfeld theory of electrical conduction in metals, Mattheissen's rule, Wiedemann Franz law.

Energy bands in solids: Origin and magnitude of energy gap, Bloch functions, Kronig Penney model (qualitative). Distinction between metals, insulators and semiconductors, Velocity of the Bloch electron, electron dynamics in an electric field, concept of hole, Effective mass of electrons and holes.

12 hrs

UNIT 4

Semiconductors: Intrinsic and extrinsic semiconductors, Intrinsic and extrinsic carrier concentrations, Law of mass action, Position of Fermi level, Electrical conductivity and mobility and their temperature dependence. Determination of band gap of intrinsic semiconductor, Hall effect and applications.

Semiconductor Devices: pn-junction: Fabrication technique, Formation of a depletion region, Energy-band diagram and junction barrier voltage, Rectifier equation, Tunnel diode, Metal oxide semiconductor field effect transistor, Silicon controlled rectifier, Unijunction transistor.

12 hrs

REFERENCES:

1. X-ray structure determination, Stout G.H. and Jensen L.H., MacMillan, USA
2. Structure determination by X-ray crystallography, Ladd M.F.C. and Palmer R.A., Plenum Press, USA
3. Elementary crystallography, Buerger M.J., Academic Press, London.
4. Solid state physics, Dekker A.J., Prentice Hall
5. Introduction to solid state physics, Kittel C., 7th Edn., John Wiley, New York
6. Solid state and semiconductor physics, Mckelvey J.P., 2nd Edn., Harper and Row, USA
7. Solid state electronic devices, Streetman B.G., 2nd Edn., Prentice-Hall of India, New Delhi

8. The physics of liquid crystals, De Gennes P.G. and Prost J., 2nd Edn., Clarendon Press, Oxford
9. Solid state physics, Wahab M.A., Narosa Publishing House, New Delhi
10. Introduction to solids, Azaroff L.V., McGraw-Hill Inc, USA
11. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi
12. Solid State Physics An Introduction to Solid State Electronic Devices, Ajay Kumar Saxena, Macmillan Publishers India Ltd

SPT 1.4 B: MATERIAL SCIENCE – I (SPECIAL)

Teaching Hrs per week: 4hrs

Total Hrs: 48hrs

UNIT 1

Formation and structure of materials

Introduction to material science, Engineering materials, structure - property relationship. Review of ionic, covalent and molecular bindings- bond angle, bond length and bond energy. Lattice energy – Jones potential. Closed pack structures, packing efficiency and density of materials. Crystal morphology, symmetry elements, crystal systems. Point group symmetry-derivation of point groups, Elementary ideas on space groups. Principles of X-ray powder diffraction method, Interpretation of powder photographs and powder metallurgy.

12 hrs

Unit 2

Crystal imperfections and diffusion in solids:

Review of crystalline imperfections, Schottky and Frenkel defects, equilibrium concentrations. Line imperfections: edge and screw dislocations, Interactions of dislocations. Surface imperfections: grain boundary, tilt and twin boundaries, Volume imperfections.

Diffusions in solids, Fick's law of diffusion, Solution to Ficks law - error function. Determination of diffusion coefficients, diffusion couple. Applications based on second law Atomic model of diffusion- electrical conductivity of ionic crystals.

12 hrs

UNIT 3

Elastic and plastic behavior of materials

Atomic model of elastic behaviour, the model as a parameter in design, rubber like elasticity, an elastic behaviour, viscosity behaviour. Fracture of materials, ductile and brittle fracture, ductile brittle transition, protection against fracture.

Plastic deformation by slip, the shear strength of perfect and real crystals, CRSS, the stress to move a dislocation, work hardening and dynamic recovery. Methods of strengthening crystalline materials against plastic deformation, strain hardening, grain refinement, solid solution strengthening, precipitation strengthening.

12 hrs

UNIT 4

Phase diagrams and phase transformations

Phase diagrams, the phase rule and it's applications to binary alloy systems, isomorphous, eutectic and peritectic - the lever rule. Typical phase diagrams: Cu-Zn, Ag-Pb, Pb-Sn, Fe-C systems. Heat treatment processes: annealing, hardening and tempering.

Phase transformations, Nucleation and growth: nucleation kinetics, transformations in steel. Solidification and crystallization: recovery, recrystallization and gain growth. Microstructure: Single phase materials, Phase distribution precipitates and eutectoid decomposition, Examples of modifications of microstructure.

12 hrs

REFERENCES:

1. Elements of material science and engineering, Lawrence H. Van Vlack Addison Wesley
2. Material science and engineering, V. Raghavan, Prentice Hall
3. Nature of chemical Bond, L Pauling, Oxford and IBH
4. An introduction to crystallography, F.C. Phillips, Longman
5. Crystallography applied to solid state physics, Verma and Srivastava, New age international
6. Introduction to solid Solid state physics, C. Kittel, Wiley Eastern

7. The structure and properties of Materials vol I- IV- Rose, Shepard and Wulff, John Wiley & Sons
8. Introduction to solids, L. V Azaroff, Mc Graw Hill
9. Foundation of material science and engineering, William F. Smith, Mc Graw Hill international Editions
10. Solid state Physics Source Book, Sybil P Parker (Ed), Mc Graw Hill
11. Solid state phase transformations, V. Raghavan, Prentice hall

LABORATORY EXPERIMENTS

CPP 1.5: GENERAL PHYSICS

1. Evaluation of errors, least square fit
2. To determine the diameter of the rupee coin using the methodology of scattering theory
3. To determine the refractive index of the different glasses
4. Stefan-Boltzmann law of black body radiation
5. The shape of the hanging chain
6. Thermal conductivity Forbes method
7. Verification of Stefan – Boltzmann law by electrical method for a filament bulb.
8. To determine acceleration due to gravity using Atwood's machine
9. To determine the Velocity of light by observing Jupiter moon
10. Anharmonicity of simple harmonic oscillator
11. Hysteresis loop (B – H Curve)
12. Variation of surface tension with temperature
13. Determination of principle moments of inertia of a rigid body
14. Determination of acceleration due to gravity by video analysis
15. Study of scattering of LASER light and determination of scattering cross section

(Note: Minimum eight experiments has to be performed)

CPP 1.6: COMPUTER PROGRAMMING –I

1. Program for determination of energy of electron in 1-D potential box of infinite height
2. Program to determine the wavelength of electron of hydrogen atom
3. Program to determine the integral using trapezoidal method
4. Program to determine the inter planar spacing for the different data of KCL
5. Program to determine the characteristic root equation using least square fit method
6. Program to determine the characteristic root equation using Newton-Ramphson method
7. Program for determine the frequency of optical phonon of NaCl and KCl structures
8. Program for determine the Laguerre polynomial $L_n(x)$ and $|L_n(x)|^2$
9. Program for compute the Hermite polynomial $H_n(x)$ and $|H_n(x)|^2$
10. Program to estimate the probability density factor (spherical harmonics) using associate Legendre polynomials for H atom

(Note: Minimum eight experiments have to be performed)

CPP 1.7: ELECTRONICS (GENERAL)

1. Study of single stage RC –Coupled amplifier
2. Study of Push-pull amplifier
3. Design and study of voltage regulator using Transistor
4. Design and study of Hartley oscillator using Transistor
5. Design and study of Colpitt's oscillator using Transistor
6. Design and study of square wave and sign wave generator using Op-amp
7. Design and study of low pass and high pass filter using Op-amp
8. Study of characteristics of photodiode and photo Transistor
9. Construction and study of SR, JK and JK master-slave flip-flops
10. Determination of slew rate and gain-bandwidth product of an Op-Amp
11. Study of R-2R ladder D/A converter using Op-amp
12. Study of AM modulation and Demodulation
13. Study of transistorized FM modulator
14. Programming on 8085 microprocessor: Addition, Subtraction, Multiplication and Division
15. To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display

(Note: Minimum eight experiments have to be performed)

SPP 1.8 A: CONDENSED MATTER PHYSICS – I (SPECIAL)

1. Drawing Brillouin zones for crystal lattices
2. Exact calculation and Born-Oppenheimer approximation for vibrations of diatomic molecules
3. Fermi energy of copper
4. Determination of energy gap of a semiconductor (Thermistor)
5. Characteristics of photo transistor and photodiode
6. To determine the ideality factor, drift current and reverse saturation current of a semiconductor diode
7. Characteristics of a SCR
8. Determination of specific heat of metals
9. To study the tunnel diode characteristics
10. To study the MOSFET characteristics.
11. To study the UJT characteristics
12. To determine Boltzmann Constant (k) using I-V characteristics of Si/Ge P-N junction Diode
13. Determination of thermo-electric power at a certain temperature of a given thermocouple
14. Study of lattice dynamics

(Note: Minimum eight experiments have to be performed)

SPP 1.8 B: MATERIAL SCIENCE – I (SPECIAL)

1. Determination of crystallite size of ZrO_2 nanoparticles by Scherer's and W-H plot methods
2. Determination of optical constants Band gap Energy (E_g) and Refractive index (η) using absorbance data of $ZnO:Cr^{3+}$ Nano particles
3. Analysis of X-Ray diffraction photograph of KCl
4. Determination of Rietveld refinement parameters of MgO nanoparticles using Fullprof suit software
5. Estimation of cell parameter and bond length of ZnO nanoparticles
6. Analysis of T.L. glow curve of $ZnAl_2O_4$: Eu^{3+}nanoparticles to estimate its trap parameters
7. Estimation of Band gap Energy (E_g) and Refractive index (η) of CuO nanoparticles prepared via solution combustion route
8. Estimation of crystallite size of CdO nanoparticles from W-H and size strain plot methods
9. Synthesis and estimation of Band gap Energy (E_g) and Refractive index (η) of TiO_2 nanoparticles
10. Judd-Ofelt analysis of $Y_2O_3:Dy^{3+}$ nanoparticles

(Note: Minimum eight experiments have to be performed)

SEMESTER-II

CPT 2.1: QUANTUM MECHANICS – I

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Origin of Quantum Physics: Experimental background, inadequacy of classical physics, Particle aspect of radiation and wave aspect of particles, Wave particle duality.

Basic postulates: Basic postulates of quantum mechanics; Principle of linear superposition, Wave packets, Wave functions, probabilistic interpretation and normalization of wave function.

General formalism: Hilbert space and Dirac notation, Operators - Hermitian operators, observables; Eigen functions, eigenvalues and orthonormalization of Eigen functions, completeness. probability amplitude and expectation values. Uncertainty principle and Ehrenfest's theorem.

12 hrs

UNIT 2

Wave mechanics: Schrodinger wave equation for free particle in one and three dimensions – equation subject to forces. Eigen value problems – The potential step, potential barrier and well, Infinite and finite square well potential, tunneing through a barrier, transmission and reflection coefficients.; The harmonic oscillator, numerical solution to Schrodinger equation. Wave function in coordinate and momentum representations.

Hydrogen atom: Particle in spherically symmetric potential, Reduction of two body problem to a single particle problem. eigenvalues and eigenfunctions. Hydrogen like atom, eigenvalues of energy and eigenfunctions.

12 hrs

UNIT 3

Angular momentum: The orbital angular momentum commutation relations, eigen values and eigen functions, central potential, separation of variables in the Schrodinger equation, the radial equation, the hydrogen atom.

General operator algebra of angular momentum operator components, ladder operators, eigen values and eigen vectors of J^2 and J_z, matrix representations of angular momentum operators, Pauli matrices, addition of angular momentum, Clebsch-Gordan coefficents for the case, $j_1 = j_2 = \frac{1}{2}$.

12 hrs

UNIT 4

Time Independent Perturbation Theory: Eigenvalue of energy and eigenfunction in the first order approximation (the case of a system with non-degenerate energy levels). Application to anharmonic oscillator and to the ground state of Helium atom.

Time Dependent Perturbation Theory: Concept of the theory, transition from one discrete level to the other, to a continuum states: Fermi's Golden rule. The harmonic perturbation, resonance transitions. Semi classical theory of Einstein's A and B coefficients. Interaction of radiations with a system of atoms, transition dipole moment, selection rules.

12 hrs

REFERENCES:

1. Quantum Mechanics, E. Merzbacher, 3rd edition, John Wiley
2. Quantum Mechanics, V.K. Thankappan, Wiley Eastern
3. A Textbook of Quantum Mechanics, P.M. Mathews and K. Venkatesan, TMH
4. Introduction to Quantum Mechanics, R. L. Liboff, Pearson Education
5. Principles of Quantum Mechanics, R. Shankar, 2nd edition, Plenum US
6. Quantum Mechanics: Theory and Applications, A Ghatak and S Lokanathan, Macmillan

7. Quantum Mechanics, L. I. Schiff, 3rd ed. McGraw-Hill
8. Modern Quantum Mechanics, J. J. Sakurai, Addison Wesley
9. Quantum Mechanics, B. Bransden, C. Joachain, 2nd ed, Pearson/Prentice Hall
10. A Modern Approach to Quantum Mechanics, J. S. Townsend, 2nd ed, McGraw Hill
11. Quantum Mechanics C. Cohen-Tannoudji, B.Diu, F. Laloe, (2 vol. set),Wiley Inter science
12. Quantum Physics (3rd ed): S. Gasiorowicz, Wiley India (P) Ltd., New Delhi
13. Quantum Mechanics (2nd ed): G. Aruldhas, Prentice Hall India Pvt. Ltd. New Delhi

CPT 2.2 STATISTICAL MECHANICS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Thermodynamics preliminaries: A brief overview of thermodynamics, Maxwell's relations, specific heats from thermodynamic relations. Thermodynamic description of phase transitions, Classification of phase transitions: phase diagram, Surface effects in condensation. Condition for phase equilibrium: Clausius-Clapeyron Equation, Van der Wall's equation of state and its applications, Irreversible thermodynamics, Onsager's reciprocity relation and its application to the Peltier effect and Seebeck effect.

12 hrs

UNIT 2

Classical statistical mechanics: Fundamental postulates, Liouville theorem, Microcanonical ensemble, Canonical ensemble, Grand canonical ensemble, Entropy of an ideal gas using microcanonical ensemble , Reduction of Gibbs distribution to Maxwell and Boltzmann distribution, Gibbs paradox, Sackur-Tetrode formula and resolution of the Gibbs paradox. Law of the equipartition theorem, mean value and fluctuations, Molecular partition functions: translational and rotational and vibrational partition functions.

12 hrs

UNIT 3

Quantum statistical mechanics: Postulates of quantum statistical mechanics, Density matrix, Liouville theorem in quantum statistical mechanics, Ensembles in quantum mechanics: Microcanonical ensemble, Canonical ensemble, Grand canonical ensemble, Symmetry of wave functions, Quantum distribution functions: Bose-Einstein distribution, Fermi-Dirac distribution. Boltzmann limit.

12 hrs

UNIT 4

Applications of quantum statistics: Equation of state of an ideal Fermi gas (derivation not expected), Application of Fermi-Dirac statistics to the theory of free electrons in metals, Electronic heat capacity and magnetic susceptibility, Application of Bose statistics to the photon gas, Derivation of Planck's law, Comments on the rest mass of photons, Thermodynamics of Black body radiation, Bose-Einstein condensation, Significance of Bose-Einstein condensation, Helium-I and Helium-II.

12 hrs

REFERENCES:

1. Agarwal B.K. and Eisner M., Statistical mechanics, New Age International Publishers
2. Roy S.K., Thermal physics and statistical mechanics, New Age International Publishers
3. Huang K., Statistical mechanics, Wiley-Eastern
4. Laud B.B., Fundamentals of statistical mechanics, New Age International Publishers
5. Schroeder D.V., An introduction to thermal physics, Pearson Education New Delhi
6. Salinas S.R.A., Introduction to statistical physics, Springer

SPT 2.3 A: CONDENSED MATTER PHYSICS –II (SPECIAL)

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Diamagnetism and Paramagnetism: Origin of permanent magnetic dipoles, Expression for diamagnetic susceptibility, Quantum theory of Paramagnetism.

Ferromagnetism : Review of Weiss theory of ferromagnetism, Quantum theory of ferromagnetism, Origin of internal molecular field and exchange interaction, Ferromagnetic Curie temperature, Origin of ferromagnetic domains, anisotropy energy, Bloch wall, Coercive force and hysteresis.

Anti-ferromagnetism: Characteristic property of anti-ferromagnetic substance, Neutron diffraction experiment, Two sub-lattice model molecular field theory of anti-ferromagnetism, Neel temperature.

12 hrs

UNIT 2

Magnetic Resonance : Basic principles of paramagnetic resonance, Spin-spin and spin–lattice relaxation, Susceptibility in a.c. magnetic field: power absorption, Equations of Bloch, Steady state solutions, Determination of g-factor, line width and spin –lattice relaxation time, Paramagnetic resonance and nuclear magnetic resonance, Effect of crystal field on energy levels of magnetic ions (qualitative), Spin- Hamiltonian, Zero field splitting.

12 hrs

UNIT 3

Dielectrics : Review of basic formulae, dielectric constant and polarizability, Local field, Clausius-Mossotti relation, Polarization catastrophe. Sources of polarizability, Dipolar polarizability: dipolar dispersion, Debye's equations, Dielectric loss, dipolar polarization in solids, Dielectric relaxation, Ionic polarizability, Electronic polarizability: classical treatment, quantum theory, Inter band transitions in solids.

12 hrs

UNIT 4

Ferroelectrics : General properties of ferroelectrics, Classification and properties of representative ferroelectric crystals, Dipole theory of ferroelectricity, Dielectric constant near Curie temperature, Microscopic source of ferroelectricity, Lyddane –Sachs-Teller relation and its implications, Thermodynamics of ferroelectric phase transition, Ferrroelectric domains, Piezoelectricity and its applications.

12 hrs

REFERENCES:

1. The Physical Principles of Magnetism : A. H. Morrish, John Wiley & sons, New York
2. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore
3. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore
4. Elementary Solid State Physics : M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi
5. Introduction to Magnetic Resonance: A. Carrington and A. D. Mclachlan, Harper & Row, New York
6. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi

SPT 2.3.B MATERIAL SCIENCE –II (SPECIAL)

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Metals: Review of free electron theory and Fermi distribution function, Structure and types of metals, Electronic properties of metals, Electrical and thermal conductivity, Wiedemann- Franz law, Temperature and impurity effects. Heat capacity of metals, Debye's model of specific heat, Contribution of free electrons to heat capacity, Dispersion relation, Acoustic and optical modes, Thermal expansion, Anharmonic interactions, Galvanomagnetic effects in metals.

Alloys: Solid solutions, substitutional and interstitial, Hume Rothery rules, Super lattice, long range order theory, Diffusion in alloys, Darkens equation. Some special alloys: ferrous and nonferrous, super alloys.

12 hrs

UNIT 2

Semiconductors and Superconductors:

Semiconductors: Review of band theory of solids, direct and indirect band gaps, charge carrier in intrinsic semiconductor. Extrinsic semiconductor, effect of doping and mobility of charge carriers. Methods of doping: alloying, diffusion and ion implantation. Preparation of semiconductor single crystals.

Superconductivity: Superconducting tunneling phenomena. AC and DC Josephson effect. Applications: Superconducting magnets, super density switches, SQUID. HTS superconductors, materials preparation and structure.

12 hrs

UNIT 3

Dielectrics and Ferroelectrics

Dielectrics: Review of dielectric polarization, internal field and macroscopic field. The Complex dielectric constant, dielectric losses and relaxation time, Debye equations, Theory of electronic polarization and optical absorption. Dielectric function, LST Relationship, dielectric breakdown, General applications of dielectric materials, Ferroelectrics Piezoelectric, pyroelectric and ferroelectric materials, transducer and detector applications, Classification of ferroelectrics. Ferro electricity in KDP and barium titanate, order-disorder and displacement theories. Thermodynamics of ferroelectric phase transitions.

12 hrs

UNIT 4

Magnetic Materials and Magnetic Resonance:

Magnetic Materials: Review of dia, para and ferro- magnetic materials, Spontaneous Magnetization, temperature dependence, gyromagnetic experiments. Origin of Ferromagnetic domains, Anisotropy of magnetostriction and Bloch wait energies. Antiferromagnetic and ferrimagnetism- Sublattice model, Neel's theory. Neutron Diffraction in magnetic structure analysis. Hard and soft magnetic materials- areas of Their application.

Magnetic Resonance: Elements of theory of nuclear magnetic resonance (NMR)-rate of energy absorption- spin lattice and spin-spin relaxation- Bloch equations, Principles of ESR, NOR and Mossbauer techniques, typical areas of application.

12 hrs

REFERENCES:

1. Introduction to Properties of Materials, D. Rosenthal and R M Asirnov, East West
2. Elements of Materials Science and Engineering, L H Van Vlack, Addison Wesley
3. Introduction to solid state Physics, C. Kittle, Wiley Eastern
4. Solid State Physics, A. J. Dekker, Mc Milan India
5. Introduction to solids, L V Azaroff, Mc Graw Hill
6. Electronic Materials, S. Murak, Academic Press

7. Superconductivity and Superconducting Materials, A. V. Narlikar and S. N. Ekbote, South Asian Publications
8. Semiconductor Physics, P S Kireev, Mir Publishers
9. Solid State and semiconductor Physics, John Mckelvey, Harper and Low
10. Modern Magnetism, L F Bates, Cambridge University Press
11. Electronic Properties of Materials, Rolf E. Hummel, Springer lag
12. Physics of dielectric Materials, B. Tareev, Mir Publishers
13. Magnetic Resonance- C P Slichter , Harper and Row
14. NQR Spectroscopy, SSP Suppl. I T P Das and E. L. Hahn, Academic Press
15. Mossbauer Effect and its Applications, V G Bhide, Tata McGraw Hill

OET 2.4: MODERN PHYSICS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Blackbody Radiation: Nature of Blackbody spectrum, Classical radiation laws and their limitations, Planck's radiation law and quantum hypothesis.

The Photoelectric Effect: Experimental arrangement of the Photoelectric Effect, Laws of Photoelectric Effect, Einstein Photoelectric Equation.

X-Rays: Nature and production of X-rays, Bragg law, Bragg X-ray crystal spectrometer.

The Compton Effect: X-ray Compton scattering from an electron, Experimental set-up for Compton scattering.

12 hrs

UNIT 2

Atomic Structure: Hydrogen spectrum, Bohr model, Experimental measurement of the Rydberg constant, Franck-Hertz experiment.

Matter Waves: The de Broglie wavelength and its relation with the Bohr model, Davisson-Germer experiment, Heisenberg Uncertainty principle, Momentum-position and Energy-time relations.

Quantum Physics: Idea of wave function and probability, One-dimensional Schrödinger wave equation and its application to the particle in a box and hydrogen atom, Energies and wave functions.

12 hrs

UNIT 3

Molecular Structure: Bonding mechanisms: Ionic bonds, Covalent bonds, Hydrogen bond and Van der Waals bonds, Molecular vibration and rotation spectra, Molecular orbitals: Hydrogen molecular ion and molecule.

Solid State Physics: Ionic solids, covalent solids, metallic solids, molecular crystals, amorphous solids, Classical models of electrical and heat conductivities in solids, Ohm's Law, Wiedemann-Franz law.

Lasers: Absorption, Spontaneous and Stimulated emissions, Population inversion, Pumping techniques, Laser action, Ruby Laser.

12 hrs

UNIT 4

Magnetism: Magnetic moment, Hysteresis and Magnetization, Magnetic materials: Diamagnetic, paramagnetic and ferromagnetic materials.

Nuclear Structure: Nuclear properties: Charge, Mass, Size and Structure, Nuclear spin and magnetic moment, Nuclear Magnetic Resonance (NMR) phenomenon, Binding energy and nuclear forces, Liquid drop model, Radioactivity: Decay constant, Half-life.

Theory of Relativity: Michelson-Morely experiment, Postulates of special theory of Relativity, Time dilation, Length contraction, Simultaneity of events, Mass-energy equivalence.

12 hrs

REFERENCES:

1. Modern Physics (2nd Ed) Serway, Moses and Moyer, Saunders College Publishing
2. Fundamentals of Physics extended with Modern Physics (4th Ed) Halliday, Resnick and Walker, John Wiley
3. Concepts of Modern Physics by Arthur Beiser, Mcgraw- Hill Higher education

LABORATORY EXPERIMENTS

CPP 2.5: MODERN PHYSICS – I

1. Coin Toss: Idea of probability and statistics
2. Young's double slit experiment by Laser
3. Diffraction of laser light – single slit
4. Diffraction of laser light - diffraction grating
5. Quantum particle in a 1-D box
6. Quantum particle in a harmonic trap
7. Rydberg constant (Chart)
8. Determination of absorption co-efficient of a solution
9. Study of photovoltaic cell (Solar cell) Characteristics
10. Photoconductor (LDR) characteristics: Determination of material constant, dark resistance and saturation resistance
11. Study of LASER diode characteristics
12. Hartmann's formula using prism spectrometer
13. Faraday effect in a solid or liquid

(Note: Minimum eight experiments have to be performed)

CPP 2.6: COMPUTER PROGRAMMING-II

1. Write a C program to find root for the given equation using bisection method
2. Write a C program to obtain solution of differential equation using Euler's method
3. Write a C program to obtain solution of differential equation using Runge kutta 4^{th} order method
4. Write a C program to find the characteristic root (or) Eigen values of the given matrix
5. Write a C program to non-linear curve fitting a straight line
6. Write a C program to find the value of integral using Simpson's $1/3^{rd}$ rule
7. Write a C program to find the value of integral using Simpson's $3/8^{th}$ rule
8. Write a C program to obtain solution of differential equation using Runge kutta 2^{nd} order method
9. Write a C program to solve system of linear and non-homogenous equation using Gauss elimination method
10. Write a C program to find the non-linear first order partial differential equation using Jacobi method

(Note: Minimum eight experiments have to be performed)

SPP 2.7A: CONDENSED MATTER PHYSICS-II (SPECIAL)

1. Determination of temperature dependence of chemical potential of a free Fermi gas in one, two and three dimensions
2. Determination of temperature dependence of chemical potential of a free Bose gas in one, two and three dimensions
3. Determination of dielectric constant of a material
4. Magnetic Hysteresis
5. Paramagnetic susceptibility by Gouy's balance method
6. Determination of paramagnetic susceptibility of a given salt by Quincke's method
7. Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material
8. Determination of Hall coefficients and estimation of charge carrier concentration
9. Determination of specific heat of metals
10. Determination of Curie temperature of a ferromagnetic
11. Dielectric constant of non-polar liquids (benzene)
12. To determine the thermal conductivity of given dielectric material using Lee's Disc Method
13. Diamagnetic susceptibility of water molecule
14. Determination of Debye temperature of Lead Or Tin
15. Temperature dependence of Susceptibility of a Paramagnetic substance

(Note: Minimum eight experiments have to be performed)

SPP 2.7B: MATERIAL SCIENCE-II (SPECIAL)

1. Determination of optical constants η and K using the transmission data of ZBV thin film
2. Determination of crystallite size of MgO nanoparticles using different W-H plot methods
3. Determination of Rietveld refinement parameters of CuO:Zn nanoparticles using Fullprof suit software
4. Determination of optical constants η and K using the transmission data of VZP thin film
5. Synthesis and estimation of Band gap Energy (E_g) and Refractive index (η) of ZnO nanoparticles
6. Determination of crystallite size of MgO nanoparticles synthesized using different fuels
7. Synthesis and estimation of Band gap Energy (E_g) and Refractive index (η) of NiO nanoparticles
8. Analysis of T.L. glow curve of $CaZrO_3:Sm^{3+}$ nanoparticles to estimate its trap parameters.
9. Synthesis and estimation of Band gap Energy (E_g) and Refractive index (η) of CuO nanoparticles.
10. Judd-Ofelt analysis of $MoO_3:Eu^{3+}$ nanoparticles.

(Note: Minimum eight experiments have to be performed)

OEP 2.8: MODERN PHYSICS

1. Analysis of Raman Spectrum of N_2 molecule
2. Analysis of Rotational –Vibrational Spectrum
3. Wavelength of Laser
4. Stefan-Boltzmann's Law (Electrical method)
5. Stellar Spectra
6. Determination of Rydberg's Constant
7. Determination of Planck's Constant
8. Photoelectric Effect
9. Refractive Index of glass
10. Experiments with LEDs
11. Verification Inverse Square Law by Gamma Radiation
12. Michelson Morley experiment
13. Study of LDR Characteristics
14. Determination cell parameters for a X-ray powder diffractogram
15. Measurement of diameter of human hair and a wire using Laser

(Note: Minimum eight experiments have to be performed)

SEMESTER-III

CPT 3.1: QUANTUM MECHANICS –II

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Linear Vector Algebra: Linear Vectors space, Orthonormality, linear independence. Operators. Eigenvalues, eigenvectors; Hermitian, Unitary and Projection operators. Bra and Ket notation for vectors. The elements of representation theory. Idea of Measurements, Observables and generalized uncertainty relation. Coordinate and momentum representations. Quantum Poisson Bracket. Quantum Dynamics: Schrödinger and Heisenberg pictures; Interaction picture; the Heisenberg equation of motion. Linear harmonic oscillator problem by matrix method.

12 hrs

UNIT 2

Elastic Scattering: Differential and total cross section, phase analysis. Significance of the partial waves and phase shifts, S wave scattering from a square well potential. The Born approximation, derivation of the expression for differential scattering cross section, condition for validity of the approximation: application to square well potential and screened coulomb potential.

12 hrs

UNIT 3

Approximation Methods: First order stationary perturbation theory for a degenerate case; the secular equation; applications: particle in an infinitely deep potential well subject to perturbing potential and, Stark effect in hydrogen atom; Second order perturbation theory and its application to a linear harmonic oscillator subject to a potential. W.K.B. approximation: Connection formulas; application to a potential well and alpha decay. The Variation method and its application to the ground state of hydrogen atom and helium atom.

12 hrs

UNIT 4

Relativistic Quantum Mechanics: Klein–Gordon equation. Dirac's relativistic equation for a free particle: commutation relations and matrices for α and β; free particle solutions; probability charge and current densities; positive and negative energy states; the spin of the Dirac particle. Dirac equation in electromagnetic potentials and magnetic moment. Dirac equation for a central field; the hydrogen atom: energy levels and fine structure (without derivation).

12 hrs

REFERENCES:

1. Quantum Mechanics (2nd Edition) : L. I. Schiff, McGraw – Hill Co, New York
2. Introduction to Quantum mechanics, David J. Griffiths, 2nd Edition, Parson Education
3. Quantum Mechanics (Vol. I) : A. Messiah, North Holland Pub Co, Amsterdam
4. Quantum mechanics, V.K Thankappan, 2nd Edition, New Age International (P) Limited, Publishers
5. Quantum Mechanics – Theory and Applications (3rd Edition): A. Ghatak and S. Lokanathan, MacMillan India Ltd. New Delhi
6. Relativistic Quantum mechanics and Relativistic Quantum fields, J.D. Bjorken and S.D. Drell, McGraw-Hill, New York
7. The Principles of Quantum Mechanics (4th Edition) : P.A.M. Dirac, Oxford University Press, New York
8. Quantum Mechanics : E. Merzbacher., John Wiley, New York
9. Applied Quantum Mechanics: A.F.J Levi, Cambridge University Press

CPT 3.2 NUCLEAR PHYSICS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Interaction of charged particles: Energy loss of heavy charged particles in matter, Bethe-Bloch formula, Energy loss of fast electrons, Bremstrahlung.

Interaction of gamma rays: Photo electric, Compton, and pair production processes. Gamma ray attenuation: attenuation coefficients, absorber, mass thickness, cross sections.

Nuclear reactions: Cross section for a nuclear reaction, Differential cross section, Q-value of a reaction, Threshold energy, Direct and compound nuclear mechanisms, Bohr's independence hypothesis and experimental verification.

Nuclear fission: Energy released in fission, Neutron cycle in a thermal reactor, Four factor formula.

12 hrs

UNIT 2

Nuclear forces: Characteristics of nuclear forces, short range, saturation, Charge independence and exchange characteristics, Ground state of deuteron, Relation between the range and the depth of the potential using square well potential, Yukawa's theory of nuclear forces (qualitative only).

Nuclear detectors: Scintillation detectors- NaI(Tl), Plastic scintillation, Scintillation spectrometer.

Semiconductor detectors: Surface barrier detectors, Li ion drift detectors, Relation between applied voltage and the depletion region in junction detectors, Counter telescopes, Particle identification, Position sensitive detector.

12 hrs

UNIT 3

Nuclear models:

Liquid drop model: Semi-empirical mass formula, Stability of nuclei against beta decay, mass parabola.

Fermi gas model: Kinetic energy for the ground state, asymmetry energy.

Shell model: evidence for magic numbers, prediction of energy levels in an infinite square well potential, spin orbit interaction, prediction of ground state spin parity and magnetic moment of odd nuclei, Schmidt limit.

Nuclear decay:

Beta decay: Fermi's theory of beta decay, Curie plots and ft values, selection rules.

Gamma decay: Multi polarity of gamma rays, selection rules, internal conversion (qualitative only).

12 hrs

UNIT 4

Elementary particle physics: Types of interactions between elementary particles, Hadrons and Leptons, Detection of neutrinos.

Symmetries and conservation laws: Conservation of energy, momentum, angular momentum, charge and isospin, Parity symmetry, violation of parity in week interactions, Lepton number conservation, Lepton family and three generations of neutrinos. Conjugation symmetry, CP violation in week interactions.

Strange particles: Conservation of strangeness in strong interactions, Baryon number conservation, Gell-Mann Nishijima formula, Eight fold way (qualitative only), Quark model, Quark content of baryons and mesons, Color degree of freedom, standard model (qualitative only).

12 hrs

REFERENCES:

1. Introduction to Nuclear Physics H. Enge, Addison Wesley
2. Atomic and Nuclear Physics, S. N. Goshal, Vol II, S. Chand Publishing
3. Introductory Nuclear Physics Kenneth S. Krane, John Wiely and Sons
4. The Atomic Nuclease Evans R. D., Tata Mc. Graw hill
5. Nuclear Physics, R R Roy and Nigam, Wiley-eastern Ltd
6. Nuclear physics an introduction, S. B. Patel, New age international (P) limited
7. Radiation Detection and Measurements, G.F. Knoll, 3rd edition, John Wiely and sons
8. Nuclear Radiation Detectors, S. S. Kapoor and V.S Ramamurthy, Wiley and sons. Introduction to High Energy Physics D. H. Perkins, Addison Wesley, London
9. Introduction to Elementary Particles, D. Griffiths, john Wiley
10. Nuclear Interactions, S.de Benedetti, John Wiley, New York

SPT 3.3 A: CONDENSED MATTER PHYSICS –III (Special)

Teaching Hrs per week: 4hrs

Total Hrs: 48hrs

UNIT 1

Superconductivity: Properties of superconductors, Experimental survey: Persistent current, Effect of magnetic field, Meissner effect, Type I and Type II superconductors, Thermodynamics of superconducting transition, Entropy, Specific heat, London equations: London penetration depth, Flux quantization, Superconductivity at high frequencies, BCS theory of superconductivity: Gap in the energy spectrum of conduction electrons in a superconductor, Electron pair formation, Behaviour in an external electric field, Josephson junction and Josephson effect, Applications superconductivity: Cryotron switches, SQUIDS.

12 hrs

UNIT 2

Disordered systems: Point defects, Classification, Shallow and deep impurity states in semiconductors, Localized lattice vibrational states in solids, Vacancies, interstitials in ionic crystals, Colour centres in ionic crystals: Types of Colour centres, Methods of production, Characteristic absorption bands, Properties of Colour centres and Applications, Imperfections in crystals, Mechanism of plastic deformation in solids, Stress and strain fields of screw and edge dislocations, Elastic energy of dislocations. Photoconductivity, Luminescence.

12 hrs

UNIT 3

Disorder in Condensed Matter : Introduction, Short range order and long range order, Ordered lattice, Disordered lattice: Compositional. Disorder, Topological disorder, Magnetic disorder, Localized states, Anderson Model, Density of states, Concept of glass, Glass transition temperature, Atomic correlation function, Structural description of glasses and liquids,

Amorphous semiconductors: Classification, Band structure, Electronic conduction, Optical absorption, Switching, Transport in disordered lattices, Transport in extended states, Fixed range and variable range hopping, Conductivity in impurity bands.

12 hrs

UNIT 4

Films and Surfaces : Methods of preparation: Thermal evaporation, Sputtering: DC, AC, diode, triode, magneton, ion beam sputtering, Laser and electron beam evaporation technique, Chemical vapour deposition, Characterization: Optical methods of film thickness determination: Fizeau fringes- FECO Method. Mechanical techniques: Stylus method, weight measurement and crystal oscillators. Structural characterization: Scanning electron microscopy, Transmission Electron microscopy and Atomic Force Microscopy, Mechanical properties: Internal stress and strain analysis, Electrical properties of thin films, Measurement of resistivity by four probe method, Thin film resistors, Magnetic properties, Film size effect on MS- films for memory devices.

12 hrs

REFERENCES:

1. Solid State Physics, A. J. Dekker, McMillan India Ltd
2. Luminescence of Solids, D. R. Vij, Plenum Press
3. Elementary dislocation theory, J. Weertman and J.R. Weertman, Macmillan Co., New York
4. Crystallography Applied to Solid State Physics, Verma and Srivasthava, New age International publishers
5. Introduction to Solid State Physics, C. Kittel, John Wiley and Sons
6. Principles of the Solid State by H.V. Keer, New Age International Publishers
7. Electronic Processes in Non-Crystalline Materials. N. F. Mott and E. A. Davis. Oxford University Press

8. Thin Film phenomenon, K.L. Chopra, McGraw Hill Book Company
9. Introduction to solid state theory, Otfried Madelung, Springer series
10. Introduction to Solid State Physics, Arun Kumar, PHI Learning Private Limited
11. Solid State Physics: An Introduction to Solid State Electronic Devices, Ajay Kumar Saxena, Macmillan Publishers India Ltd
12. Elementary Solid State Physics: Principles and Applications, Ali Omar, Pearson Education, Inc

SPT 3.3 B: MATERIAL SCIENCE-III (SPECIAL)

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Elements of Polymer Science: Monomers, Polymers, Classification of polymers, Synthesis of polymers, Chain polymerization, Step polymerization, Industrial polymerization methods. Average molecular weight, viscosity, size of polymer molecule. Microstructure of polymers: chemical, geometric, random alternating, block and graft polymers, stereo regular polymers. Phase transition, polymer melting and glass transition, polymer crystallinity, degree of crystallinity, crystallization and stereo isomerism. Processing of Plastic Materials: compression, injection blow, extrusion, spinning.

12 hrs

UNIT 2

Ceramics: Ceramics and their structure, Silicate structure, Preparation, forming and thermal treatments, Classification of ceramics: traditional and engineering, Dielectric, ferroelectric and piezoelectric properties of ceramics with specific examples, Ceramic magnets, Mechanical properties: strength, toughness, fatigue failure, abrasion. Basic refractory materials.

Glasses: Preparation and structure, Types of glasses- borates silicate, oxide, metallic and semiconducting glasses; tempered glass and chemically strengthened glass.

12 hrs

UNIT 3

Composite Materials: General Introduction, Matrix materials, polymer, metals, ceramics, Reinforcing materials, fibres, particles. Concrete: concrete making materials, structure, composition, properties and applications. Polymer-concrete composites, fabrication, structure, interface, properties, applications of polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon fibre composites, wood-plastic composites, dispersion strengthened. Particle reinforced fibre and laminate reinforced composites with fabrication, interface, properties and applications.

12 hrs

UNIT 4

Testing of Materials: Mechanical Testing - Universal Testing Machine. Hardness: Brinell, Vicker and Rockwell, impact testing and fatigue Testing. Optical Microscopy: Metallurgical Microscopes, sample preparation and grain size measurements. Electron microscopy: Transmission microscopy (TEM), Scanning microscopy (SEM), principle, sample preparation techniques and applications. Non-destructive testing: Ultrasonic Testing, X-ray radiography, Neutron radiography.

12 hrs

REFERENCES:

1. Textbook of Polymer Science, Fred. W. Billmeyer, John Wiley & Sons, Inc.
2. Polymer Science, V.R. Gowariker, N. V. Vistrwanathan, Jayadev Shreedhar, Wiley Eastern
3. Electronic properties of Materials, Rolf E. Hummel, Springer Verlag
4. Foundations of Materials Science and Engineering, William F. Smith, McGraw Hill international Editions
5. Elements of Materials Science and Engineering, Lawrence H. Van Vlack, Addison Wesley
6. Introduction to Ceramics, W D Kingery, H K Bower and U R Uhlman, John Wiley
7. Ultrasonics, B. Carlin, Mc. Graw Hill
8. Principles of Neutron Radiography, N D Tyufyakav and A S Shtan , Amerind Publishers

9. Applied X-rays, George L Clark, Mc. Graw Hill
10. Testing of Metallic Materials, A V K Suryanarayan , Prentice Hall India
11. Physical Metallurgy: Part I, R W Cahn and P Haasen (Ed), North Holland

OET 3.4: NANOSCIENCE AND NANOTECHNOLOGY

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Nanoscience and Nanotechnology: Definitions, Uniqueness of the nanoscale, Nanoscience in nature - Naturally Occurring nanomaterials, Historical perspective, Nanomaterials, Nanoparticles, Nanowires and Nanotubes, Nanolayers/Nanocoatings, Nanoporous materials, Properties of nanomaterials, Significance of Nanoscience, Commercial Applications. Potential health hazards and environmental risks.

12 hrs

UNIT 2

Synthesis of nanomaterials: Bottom-Up and Top-Down approach with examples, Chemical precipitation method, Sol-gel method, Chemical reduction, Physical methods: ball milling, melt mixing, RF sputtering, Physical Vapour deposition, Chemical vapour deposition, Molecular beam epitaxy, Chemical methods: colloidal synthesis and capping of nanoparticles.

12 hrs

UNIT 3

Characterization techniques: Microscopic methods: SEM, TEM, STM, AFM, Diffraction techniques: XRD, EXAFS, neutron diffraction, Spectroscopes: UV-visible, IR absorption, FTIR, Photoluminescence.

12 hrs

UNIT 4

Properties of nanomaterials: Classification: metals, semi-conductors, insulators, Band structures, Mechanical properties, Electrical properties: mobility, resistivity, Hall effect, Magnetoresistance, Optical properties: optical absorption and transmission, Photoluminescence.

12 hrs

REFERENCES:

1. Nanotechnology: Principles and practices, S. K Kulkarni, Capital Publ. Co., New Delhi
2. Nanocrystals : Synthesis, Properties and Applications, C. N. R. Rao, P. John Thomas and G.U. Kulkarni, Springer series in Materials Science 95, Springer Verlag, Berlin, Heidelburg
1. Quantum Mechanics – Vol 1 & 2, Cohen, Tannoudji, Wiley-VCH, Verlag
2. The Physics and Chemistry of Solids, Stephen Elliot & S.R. Elliot Wiley India Pvt. Ltd
3. Solid State Physics, A.J. Dekker, Macmillan Press Ltd
4. Introduction to Nanotechnology- Charles P.Poole Jr and Franks J. Owens, John Wiley & Sons
5. Electronic Transport in macroscopic systems, Supriyo Datta, Cambridge University Press
6. Nanotubes and Naowires, CNR Rao and A Govindaraj, RCS Publishing
7. Encyclopedia of Nanotechnology- Hari singh Nalwa, American Scientific Publishers
8. Essentials in Nanoscience and Nanotechnology, Narendra Kumar, Sunita Kumbhat, John Wiley and Sons

LABORATORY EXPERIMENTS

CPP 3.5: MODERN PHYSICS-II

1. Variational ground state of a particle in Physics
2. Determination of thickness of mica sheet by Edser Butler method
3. Balmer Series: Determination of Rydberg's Constant
4. Refractive index of liquids using LASER
5. Verification of WKB approximation for harmonic oscillator
6. Reflection and transmission grating
7. Planck's constant (Spectrometer)
8. Determination of e/m for electrons
9. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
10. Helmholtz coil and eddy currents
11. Specific heat capacity of graphite and its variation with temperature
12. Thermal and electrical conductivities of copper to determine the Lorentz number
13. To determine the ionization potential of mercury used inside a thyratron tube
14. Velocity of sound in air by CRO method

(Note: Minimum eight experiments have to be performed)

CPP 3.6: NUCLEAR PHYSICS

1. Simulation of nuclear decay by rolling Dice
2. Study of beta particle range and maximum energy (Feather analysis)
3. Study of nuclear counting Statistics
4. Inverse square law: gamma rays
5. Back scattering of gamma particles
6. Estimation of efficiency of the GM detector for
   a). Gamma Source and
   b). Beta Source.
7. Study of Cs-137spectrum and calculation FWHM and resolution for the given scintillation detector
8. Activity of gamma emitter (relative method and absolute)
9. Study of gamma ray interaction with sodium iodide (Nal) crystal
10. Cockcroft and Walton's voltage multiplier
11. Attenuation of gamma rays and half value thickness of the absorber
12. Coincidence and anticoincidence Circuit
13. Comparator and discriminator circuits
14. Rest mass of electron using gamma ray spectrometer
15. Schmidt trigger circuit using IC-555
16. Two stage RC coupled amplifier

(Note: Minimum eight experiments have to be performed)

SPP 3.7A: CONDENSED MATTER PHYSICS –III (SPECIAL)

1. Determination of q, n, b by hyperbolic fringes method
2. Determination of q, n, b by elliptical fringes method
3. Determination of the thickness of a given transparent plate with the help of Jamin's Interferometer
4. Computation of density of states in tight binding model for 1, 2 and 3-D lattices.
5. Computational verification of the validity of local density approximation for a harmonically trapped gas.
6. Temperature coefficient of resistance of copper
7. Dipole moment of an organic molecule
8. Investigation of the conductivity behaviour of NaCl and determination of the activation energy for Ionic conduction
9. Resistivity measurement of a thin film by four probe method
10. Determination of magnetoresistance of the material
11. To study the thermoluminescence of F-centres in Alkali halides crystals
12. Using laser beam to measure the thickness of thin film
13. Determination of k/e using a transistor
14. To measure the resistivity of an insulating material as function of temperature and hence to find the activation energy for conduction

(Note: Minimum eight experiments have to be performed)

SPP 3.7B: MATERIAL SCIENCE-III (SPECIAL)

1. Analysis of T.L. glow curve of Sr_2SiO_4: Eu^{3+}nanoparticles.
2. Determination of crystallite size of CdO (pure) and CdO: La^{3+} (doped) nanoparticles.
3. Calibration of Electromagnetic field and determination of magnetic Susceptibility of $FeCl_4$ by Quink's method.
4. Determination of Rietveld refinement parameters of $CaZrO_3$:Dy^{3+} Nanoparticles using Fullprof suit software.
5. Analysis of X-Ray powder photograph of Copper to determine its cell Parameter and density.
6. Analysis of T.L. glow curve of Ba_2SiO_3 nanoparticles.
7. Analysis of X-Ray diffraction photograph of NaCl
8. Determination of optical constants η and K using the absorption data of Gd_2O_3 nanoparticles.
9. Estimation of Band gap energy (E_g) and refractive index (η) of TiO_2 nanoparticles by Direct & Indirect methods.
10. Synthesis and estimation of Band gap Energy (E_g) and Refractive Index (η) CeO_2 nanoparticles.

(Note: Minimum eight experiments have to be performed)

OEP 3.8: NANOSCIENCE AND NANOTECHNOLOGY

1. Analysis of X-Ray diffraction photograph of NaCl
2. Analysis of X-Ray diffraction photograph of KCl.
3. Indexing powder XRD pattern by analytical method.
4. Determination of particle size of ZnO nanoparticles using powder XRD data.
5. Determination of particle size of CuO nanoparticles using powder XRD data.
6. Resistivity measurement of a material using two probe method
7. Resistivity measurement of a material using four probe method
8. Determination of energy band gap of a semiconductor using UV-Vis spectra (DRS data)
9. Determination of band gap of a semiconductor nanomaterial using UV-visible absorption spectra
10. Determination of optical constants η and K using the transmission data of ZBV thin film
11. Determination of optical constants η and K using the transmission data of VZP thin film.

(Note: Minimum eight experiments have to be performed)

SEMESTER IV

CPT 4.1: CLASSICAL ELECTRODYNAMICS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Electrostatics:

Review of vector analysis, Divergence and curl of electrostatic field, Gauss law in integral and differential forms, Electric potential, electrostatic potential energy and energy density of a continuous charge distribution, Poisson and Laplace equations, Boundary conditions and uniqueness theorem, the method of images, Multipole expansion of the potential and energy of a localized charge distribution, monopole and dipole terms, electric field of a dipole. Electric fields in matter, polarization, bound charges, Gauss law in dielectrics, linear dielectrics, and electrostatic energy in dielectric systems.

12 hrs

UNIT 2

Magnetostatics:

Magnetic fields and forces, current and current density, continuity equation, Biot-Savart law, the divergence and curl of B, Ampere's law, magnetic vector potential, multipole expansion of vector potential of a localized current distribution, magnetic moment. Torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits. Magnetic fields in matter, macroscopic equations, magnetostatic boundary conditions, magnetic scalar potential. Energy in the magnetic field.

12 hrs

UNIT 3

Electrodynamics:

Faraday law of induction, displacement current, Inductance, Maxwell's equations. Poynting's theorem, momentum, Maxwell's stress tensor, conservation of momentum.

Electromagnetic Waves: Electromagnetic waves in vacuum and in matter, Linear and circular polarizations. Reflection and refraction of plane waves, total internal reflection, electromagnetic waves in conductors, skin depth. reflection at a conducting surface. Scalar and vector potentials. Gauge transformations, Lorentz gauge, Coulomb gauge.

12 hrs

UNIT 4

Wave guides: Classification wave guides, TM and TE modes in rectangular wave guide, coaxial wave guide.

Electromagnetic radiation: Retarded Potentials. Radiation from an oscillating dipole, Lenard-Wiechert potentials, potentials for a charge in uniform motion, power radiated by an accelerated charge at low velocities, Larmor's formula , radiation from a charged particle with collinear velocity and acceleration, Bremsstrahlung radiation, radiation from a charged particle moving in a circular orbit, cyclotron and synchrotron radiation.

12 hrs

REFERENCES:

1. Classical Electrodynamics: J.D.Jackson , Wiley Eastern Ltd., Bangalore
2. Introduction to Electrodynamics: D.J.Griffiths, Prentice Hall of India, Ltd., New Delhi
3. Electromagnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore
4. Classical Electromagnetic Radiation: J.B. Marion, Academic press, NewYork
5. Classical Electrodynamics; S P Puri, Tata McGraw –Hill Publishing Company Ltd., New Delhi

CPT 4.2: ATOMIC MOLECULAR AND OPTICAL PHYSICS

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Atomic Physics: Brief review of early atomic models of Bohr and Sommerfeld: One electron atom; Atomic orbitals, spectrum of hydrogen atom: Energy levels and selection rules, Rydberg atoms, relativistic correction to the kinetic energy, Spin – orbit interaction and fine structure in alkali spectra, Lamb shift (qualitative discussion only). Interaction with external fields: (Quantum mechanical treatment) Zeeman effect and Anomalous Zeeman effect. Linear stark effect order correction to energy and Eigen states: Paschen-Back effect, Two electron atom: ortho & para states, role of Pauli exclusion principle, level schemes of two electron atoms. Many electron atoms: LS and JJ coupling scheme, Lande interval rule.

12 hrs

UNIT 2

Molecular Physics A: Brief treatment of chemical bonds: covalent, ionic, Van der waal's interactions. Classification of molecules: Rotational spectra of diatomic molecules as a rigid rotator, centrifugal distortion and non-rigid rotator, intensity of rotational lines, Rotational spectra of symmetric rotors, Experimental technique of microwave spectroscopy. Raman scattering and polarizability, Rotational Raman spectrum of diatomic and linear polyatomic molecules. Experimental technique. Applications of Raman spectroscopy: Determination of nuclear spin.

12 hrs

UNIT 3

Molecular Physics B: Diatomic molecule as a simple harmonic oscillator, anharmonicity, Morse potential curves, Vibrational Raman effect, Rovibronic spectrum of a diatomic molecule with example. Diatomic molecules in excited vibrational states. Mutual exclusion principle, Correlation between Raman and IR spectroscopy, Experimental technique of IR spectroscopy: IR spectrometer, Applications of IR spectroscopy: Material characterization and structural elucidation.

12 hrs

UNIT 4

Electronic spectra of diatomic molecules: Vibrational structure, rotational structure in electronic spectra, intensity of vibrational lines in electronic spectra, Frank-Condon principle, dissociation and pre-dissociation, fluorescence and phosphorescence.

Optical Physics: Coherence of light: spatial and temporal coherence, Einstein's Coefficients: spontaneous and stimulated emission, Idea of light amplification, Characteristics of a laser beam, Threshold condition for laser oscillation, Role of resonant cavity, He-Ne lasers, Holography: Fundamentals of 3D mapping of images, recording and reconstruction.

12 hrs

REFERENCES:

1. Physics of atoms and molecules, Bransden and Joachain, (2nd Edition) Pearson Education
2. Introduction to Atomic Spectra, H E White, McGraw Hill Kogakusha Ltd.
3. Fundamentals of Molecular Spectroscopy, Banwell and Mccash, Tata McGraw Hill
4. Molecular Spectra and Molecular Structure Vol.1, Geralhd Herzberg, D VAN NOSTRAND Company. Inc. New York
5. Modern Spectroscopy, J.M. Hollas, John Wiley
6. Molecular Quantum Mechanics, P.W. Atkins and R.S. Friedman. Third Edition, Oxford Press (Indian Edition)
7. Molecular Structure and Spectroscopy, G Aruldhas, Prentice Hall of India, New Delhi

8. Atomic and Molecular Spectra, Raj Kumar, Kedar Nath Ram Nath, Meerut
9. Lasers, Silfvast, Cambridge Press
10. Lasers, Nambiar, New Age International
11. Optical Electronics, Ghatak and Tyagarajan, Cambridge Press
12. Lasers and Nonlinear Optics- B.B. Laud, Wiley-Eastern Ltd

SPT 4.3 A: CONDENSED MATTER PHYSICS –IV (SPECIAL)

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

X-Ray Diffraction by crystals: Scattering by regular arrays of atoms, Laue Equations, Bragg Equation, Equivalence of the Laue and Bragg Equations, Reciprocal Lattice: graphical construction, vector algebraic discussion, relation between direct and reciprocal cells, Bragg's law using reciprocal lattice concept, Atomic scattering factor, Atom displacement form factors, Reciprocal Lattice and Reflection Condition: Ewald Sphere, general spacing formula.

12 hrs

UNIT 2

X-Ray Diffraction methods A: *Laue method*: Instrumentation, flat plate cameras, front reflection region, back reflection region, *Rotating crystal method*: Instrumentation, cylindrical camera, Interpretation of photographs, unit cell determination, indexing procedure, Advantages and disadvantages, *Moving film methods*: Weissenberg method, Advantages, Reciprocal lattice construction for zero level and higher levels, Indexing procedure, Interpretation of photographs. *Single crystal diffractometer*: Eularian and kappa geometry, intensity measurements.

12 hrs

UNIT 3

X-Ray Diffraction methods B: *Powder method*: X-ray powder photographic methods, Instrumentation, Diffraction geometry, Measurement of Bragg angles and interplanar spacings, Index of power patterns, analytical and graphical methods, Precise lattice parameter determination, Applications: Identification of solid solution and phase changes, Line broadening and particle size measurements, Interpretation of powder photographs of unknown system.

12 hrs

UNIT 4

Nanomaterials: Nanoscale, historical background, Quantum confinement, Surface to volume ratio, Types of nano crystalline materials: nano crystalline metals, nano crystalline ceramics, Mesoporous materials, Carbon nanotubes, nano-coatings, quantum dot, nanostructured magnetic materials, Synthesis of nanomaterials: Mechanical Milling, Sputtering (dc and ac), laser ablation, Physical Vapour deposition, Chemical Vapor Deposition, Sol–Gel Method, Characterization methods: XRD, SEM, TEM, UV-Vis and IR spectroscopy, Properties of Nanostructure materials: Electrical and mechanical properties, Applications of nanomaterials.

12 hrs

REFERENCES:

1. Elements of X-ray Crystallography, L.V. Azaroff: McGraw Hill, New York
2. An introduction to Crystallography, Michael M Wooffen: Cambridege University Press
3. Crystallography for solid state physics, Verma and Srivastava: New age international Ltd
4. X-ray crystallography, M.J.Burger: John Wiley, New York
5. The powder method in X-ray Crystallography, L.V. Azaroff and M. J. Burger, McGraw Hill, New York
6. Structure Determination by X-ray. Crystallography, Mark Ladd and. Rex Palmer, Springer-Verlag New York Inc.
7. X-Ray Diffraction: A Practical Approach, C. Suryanarayana, M. Grant Norton, Plenum Press, New York and London
8. Nanotechnology: Principles and practices, S. K Kulkarni, Capital Publ. Co., New Delhi
9. Essentials in Nanoscience and Nanotechnology, Narendra Kumar, Sunita Kumbhat, John Wiley and Sons

SPT 4.3 B: MATERIAL SCIENCE-IV (SPECIAL)

Teaching Hrs per week: 4hrs
Total Hrs: 48hrs

UNIT 1

Optical and dielectric properties of materials: Theory of electronic polarization and optical absorption, ionic polarization, orientationl polarization. Optical phonon model in an ionic crystal; Interaction of electromagnetic waves with optical modes, Polarization, Dispersion curves of transverse optical (TO) phonon and optical photon in a diatomic ionic crystal, LST relation, Metal-insulator transition. UV-VIS, IR, FTIR and Raman spectroscopy, Optical properties of metals and non-metals, Luminescence, Photoconductivity.

12 hrs

UNIT 2

Electrical properties of crystalline, nano-crystalline and polymeric materials: Resistivity variation in metals, alloys, semiconductors and nano-crystalline materials, electrical conduction in ionic ceramics, clay materials and conducting polymers. Two-probe and four probe techniques, DC and AC conductivity measurements.

Mechanical Properties of metals and ceramics: Concepts of stress and strain, stress-strain behavior, elasticity, Plastic deformation, Hardness: Knoop and Vicker's hardness test.

12 hrs

UNIT 3

Thermal properties of metals & alloys: Temperature effects on the intensities of Bragg reflections. Influence of temperature on diffraction of X-rays: Normal coordinates of lattice vibration and X-ray scattering from a vibrating lattice and origin of thermal diffuse spots. First order TDS. Debye-Waller factor' Debye's method of calculating isotropic temperature factor for a cubic crystal. DTA, TGA, DSC (Outline only). Annealing processes, Heat treatment of steels, Mechanism of hardening. Quenching, Thermal stresses.

12 hrs

UNIT 4

Structure - Property correlation: Correlation of structure with physical properties of materials, Application prospects of materials in different areas.

Basic concepts of measurements and instruments: Static characteristics of instruments, accuracy and precision, sensitivity, reproducibility, errors, Transducers: Classification and selection criteria, Principles of piezoelectric, photoelectric, thermoelectric transducers, resistance temperature transducers (RTD), Thermistor, strain gauge, load cells, LVDT Electronic instruments for measurement, Digital voltmeter, Principles of electronic multimeter, Digital multimeter, Q-meter, Electronic LCR meter, Frequency and time interval counters.

12 hrs

REFERENCES:

1. Introduction to Ceramics, W. D. Kingery, H. K. Bowen and D. R. Uhlmann, John Wiley & Sons
2. Diffraction analysis of the microstructure of materials, E. J. Mittemeijere and P. Scardi, Springer
3. Materials Science & Engineering, William D. Callister, John Wiley & Sons, Inc.
4. Modern techniques of surface science, D. P. Woodruff & T. A. Delchar, Cambridge University Press
5. X-ray spectroscopy, B. K. Agarwal, Springer, Verlag.

LABORATORY EXPERIMENTS

CPP 4.5: MODERN PHYSICS-III

1. To calculate the beam divergence and spot size of the given laser beam.
2. Ultrasonic wave velocity in a liquid medium
3. Temperature dependence of the resistivity of a metal
4. Solution to Laplace's equation using method of relaxation
5. Determination of solar constant and Sun's surface temperature
6. Verification of Malus law
7. Determination of refractive index by Brewster angle measurement
8. Determination of wavelength of sodium light using Fresnel biprism
9. Determination of e/m by Millikan's oil drop method
10. Verification of Faraday and Lenz's law induction
11. Determination of solar rotation period
12. Determination of masses of spectroscopic binary system
13. Measurement of diameter of human hair and a wire
14. Determination of h/e using photocell

(Note: Minimum eight experiments have to be performed)

CPP 4.6: ATOMIC MOLECULAR AND OPTICAL PHYSICS

1. Vibrational analysis of CN violet bands
2. Determination of numerical aperture and bending loss of an optical fibre
3. Franck Hertz experiment
4. Study of vibrational Raman spectra of diatomic molecules
5. Analysis of I_2 Absorption bands
6. Determination of Polarization state of the doublet and triplet components in longitudinal and transverse configurations
7. Recording and reconstruction of holograms and creating a holography grating.
8. Sodium doublet wavelength difference measurements
9. Study of temporal and spatial coherence of Helium-Neon Laser
10. Vibrational and Rotational analysis of emission bands of N_2
11. Estimate the diameter of the given wires using Helium-Neon Laser
12. Measurement of the wavelength of absorption bands of KMnO4 and calculate its Hartmann constant
13. Determination of birefringence of mica using Babinet compensator
14. Verification of Beers law. Determination of absorption coefficient
15. Study of sharp and diffuse series of potassium atom and calculation of spin orbit interaction constant

(Note: Minimum Eight Experiments have to be performed)

SPP 4.7A: CONDENSED MATTER PHYSICS –IV (SPECIAL)

1. Indexing powder XRD pattern by analytical method
2. Analysis of X-Ray diffraction photograph of NaCl
3. Determination of molecular structure using single crystal XRD data
4. Structure factor calculation of simple crystal structures
5. Finding accurate values of crystal parameters using FULLPROF software
6. Finding accurate values of crystal parameters using Nelson-Reiley plots of a powder XRD data
7. Determination of line broadening by Williamson-Hall plot and particle size by Scherrer's equation of a powder XRD data
8. Determination of energy band gap of a semiconductor using UV-Vis spectra (Diffused reflectance spectra)
9. Determination of band gap of a semiconductor nanomaterial using UV-visible absorption spectra
10. Cooling Curve Of A Pb-Sn Eutectic Alloy
11. Estimation of particle size using SEM images
12. Study of variation of resistivity with temperature of a thin film by four probe method
13. Resistivity measurement of a material using two probe method
14. Synthesis of nanomaterial

(Note: Minimum Eight Experiments have to be performed)

SPP 4.7B: MATERIAL SCIENCE-IV (SPECIAL)

1. Analysis of X-Ray diffraction photograph of single crystal using Bernal chart
2. Analysis of T.L. glow curve of $YaAl_2O_4$ nanoparticles by deconvolution method
3. Analysis of T.L. glow curve of ZnO nanoparticles by deconvolution method
4. Judd-Ofelt of $SnO_2:Eu^{3+}$ nanoparticles
5. Determination of Rietveld refinement parameters of LaOF: Eu^{3+} nanoparticles using Fullprof suit software
6. Synthesis and estimation of Band gap Energy (E_g) and Refractive index (η) of Fe_2O_3 nanoparticles
7. Verification of temperature response of NTC thermistor and determination of its Band gap Energy (E_g)
8. Judd-Ofelt analysis of $CeO_2:Eu^{3+}$ nanoparticles
9. Determination of Electrical resistivity of thin films nanoparticles by deconvolution method.by four probe method
10. Analysis of T.L. glow curve of $CaSiO_3:Eu^{3+}$

(Note: Minimum Eight Experiments have to be performed)

THEORY QUESTION PAPER PATTERN

Instruction to Candidates: Answer all the questions. **Max. Marks = 70**

1. **Answer any NINE questions in two sentences.** (Which includes all units) **9 X 2 = 18**
   - a.
   - b.
   - c.
   - d.
   - e.
   - f.
   - g.
   - h.
   - i.
   - j
   - k
   - l

Answer the following questions:

2. Essay type question or **10**

3. Essay type question or **10**

4. Essay type question or **10**

5. Essay type question or **10**

6. **Answer any THREE questions** **3 X 4 =12**
   - a.
   - b.
   - c.
   - d.

NOTE:

- Equal weightage must be given to all units while setting the question paper.
- Problems can be given but not exceeding 20 marks.

Internal marks for theory paper 30 marks

PRACTICAL QUESTION PAPER PATTERN

1. Experiments, Spotting, Demonstration	30 marks
2. Records and Viva-Voce	5 marks
3. Internal marks for practical	15 marks

PROCEEDINGS OF THE B. O.S MEETING

The B.O.S. in Physics of Tumkur University is held on 6th March 2023 at 11 A. M. in Department of Physics, Tumkur University, Tumkur. The Chairman welcomed all the members for the meeting. The board members reviewed and approved the M.Sc. Physics syllabus to be implemented 2023-2024 onwards.

The following members attended the meeting.

Sl. No.	NAME		SIGNATURE
1	Dr. Nagabhushana H	-Chairman	
2	Dr. Eraiah B	- Member	6/3/23
3	Dr. Veerabhadrayya M	- Member	
4	Dr. Mangala Gowri M	- Member	Mangalagowri M.

Place: Tumkur

Date: 06/03/2023

Chairman, B.O.S in Physics