DEPARTMENT OF STUDIES AND RESEARCH IN PHYSICS

Course Structure & Syllabus Choice Based Credit System (CBCS)

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 Examn.	Total Marks
1	CPT-1.1	Classical Mechanics	4	4	3 Hrs	20	80	100
2	CPT-1.2	Mathematical and Computational Physics	4	4	3 Hrs	20	80	100
3	CPT-1.3	Electronics Circuits, Devices and Communication	4	4	3 Hrs	20	80	100
4	SPT-1.4.1	Condensed Matter Physics-I	4	4	3 Hrs	20	80	100
	SPT-1.4.2	Material Science-I	4	4	3 Hrs	20	80	100
5	CPP-1.5 (1.1)	**Practical :** General Physics	2	2		10	40	50
6	CPP-1.6 (1.2)	**Practical :** Computer programming –I	2	2		10	40	50
7	CPP-1.7 (1.3)	**Practical :** Electronics (General)	2	2		10	40	50
8	SPP-1.8(1.4.1)	**Practical :** Condensed matter Physics-I	2	2		10	40	50
	SPP-1.8(1.4.2)	**Practical :** Material Science -I	2	2		10	40	50
		Total	**24**	**24**				**600**

Note: CPT: Core paper theory — CPP: Core paper practical

SPT: Special paper theory — SPP: Special paper practical

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BOSINPHYSICS

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 Examn.	Total Marks
1	CPT- 2.1	Quantum Mechanics-I	4	4	3 Hrs	20	80	100
2	CPT- 2.2	Statistical Mechanics	4	4	3 Hrs	20	80	100
3	SPT-2.3.1	Condensed Matter Physics-II	4	4	3 Hrs	20	80	100
	SPT-2.3.2	Material Science-II	4	4	3 Hrs	20	80	100
4	OET– 2.4	Modern Physics	4	4	3 Hrs	20	80	100
5	CPP-2.5(2.1)	**Practical :** Modern Physics – I	2	2		10	40	50
6	CPP-2.6(2.2)	**Practical:** Computer programming-II	2	2		10	40	50
7	SPP-2.7.1 (2.3.1)	**Practical:** Condensed Matter Physics-II	2	2		10	40	50
	SPP-2.7.2 (2.3.2)	**Practical :** Material Science-II	2	2		10	40	50
8	OEP-2.8 (2.4)	**Practical :** Modern Physics	2	2		10	40	50
		Total	**24**	**24**				**600**

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OET: Open Elective Theory — OEP: Open Elective practical

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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 Examn.	Total Marks
1	CPT- 3.1	Quantum Mechanics-II	4	4	3 Hrs	20	80	100
2	CPT- 3.2	Nuclear Physics	4	4	3 Hrs	20	80	100
3	SPT- 3.3.1	Condensed Matter Physics-III	4	4	3 Hrs	20	80	100
	SPT- 3.3.2	Material Science-III	4	4	3 Hrs	20	80	100
4	OET – 3.4	Nanoscience and Nanotechnology	4	4	3 Hrs	20	80	100
5	CPP-3.5 (3.1)	**Practical :** Modern Physics –II	2	2		10	40	50
6	CPP-3.6 (3.2)	**Practical :** Nuclear Physics	2	2		10	40	50
7	SPP-3.7.1 (3.3.1)	**Practical:** Condensed Matter Physics –III	2	2		10	40	50
	SPP-3.7.2 (3.3.2)	**Practical:** Material Science-III	2	2		10	40	50
8	OEP-3.8 (3.4)	**Practical:** Nanoscience and Nanotechnology	2	2		10	40	50
		Total	**24**	**24**				**600**

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SPT: Special paper theory — SPP: Special paper practical
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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 Examn.	Total Marks
1	CPT- 4.1	Classical Electrodynamics	4	4	3 Hrs	20	80	100
2	CPT- 4.2	Atomic Molecular and optical Physics	4	4	3 Hrs	20	80	100
3	SPT- 4.3.1	Condensed Matter Physics-IV	4	4	3 Hrs	20	80	100
	SPT -4.3.2	Material Science-IV	4	4	3 Hrs	20	80	100
5	CPP-4.4 (4.1)	**Practical:** Modern Physics-III	2	2		10	40	50
6	CPP-4.5 (4.2)	**Practical:** Atomic Molecular and optical Physics	2	2		10	40	50
7	SPP- 4.6 (4.3.1)	**Practical:** Condensed Matter Physics –IV	2	2		10	40	50
	SPP- 4.6(4.3.1)	**Practical:** Material Science-IV	2	2		10	40	50
8	Project 4.7		6	6		30	Viva Voce-20 Dissert.-100	150
		Total	**24**	**24**				**600**

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SPT: Special paper theory — SPP: Special paper practical
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INTERNAL ASSESSMENT, SEMINAR AND EXTRA ACTIVITIES

Internal Assessment Marks allotment basis

1st Test for 10 marks: 10

2st Test for 10 marks: 10

Average of two tests for marks: 10

Seminar (Environmental perspectives, Journal club and Environmental Hotspots)	*05*
Extra activities (Awareness programmes for general public, extension activities etc…)	*05*
Total	: 20

SEMESTER-I

CPT 1.1: CLASSICAL MECHANICS

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

Unit 1:

The Lagrangian method: Constraints and their classifications. Generalized coordinates. Virtual displacement, D'Alembert's principle and Lagrangian equations of the second kind. Examples: (I) Single particle in (a) Cartesian coordinates, (b) Spherical polar coordinates and (c) Cylindrical polar coordinates, (II) Atwood's machine and (III) a bead sliding on a rotating wire in a force-free space. (IV) Simple pendulum. Derivation of Lagrange equation from Hamilton principle. Importance and simple applications of Lagrangian formulism, Symmetry and conservation laws, cyclic coordinates.

12 hrs

Unit 2

Central force problem: Motion of a particle in a central force field, Conservation of energy and angular momentum, classification of orbits, stability of orbits, Kepler's laws of planetary motion. Scattering in a central potential in Laboratory and centre of mass frames of reference, Impact parameter, Total and differential cross section, Rutherford scattering.

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:

Mechanics of rigid bodies: Degrees of freedom of a free rigid body, Angular momentum and kinetic energy of rigid body. Fixed and moving coordinates, coriolis force, coriolis force acting on falling body. Moment of inertia tensor, principal moments of inertia, products of inertia, the inertia Tensor, Euler equations of motion for a rigid body. Torque free motion of a rigid body. Precession of earth's axis of rotation, motion of symmetrical top-rotational motion.

12 hrs

References:

1. Classical mechanics, H. Goldstein, C. Poole, J. saflco. 3rd edition. Pearson Education inc. (2002).
2. Classical mechanics. K. N. Srinivasa Rao, University press (2003).
3. Classical mechanics, N. C. Rana and P.S. Joag Tata McGraw-Hill (1991).
4. Classical dynamics of particles and systems, J. B. Marion, Academic press (1970).
5. Introduction to Classical mechanics. Takwale and Puranik, Tata McGraw-hill (1983)
6. Classical mechanics, L. D. Landau and E. M. Lifshitz, 4thedition, Pergamon Press (1985).
7. S.L. Gupta, V. Kumar and H.V. Sharma, Classical Mechanics (Pragati Prakashan, Meerut, 2001).

CPT 1.2: MATHEMATICAL AND COMPUTATIONAL PHYSICS

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

Unit 1:

Vector Analysis: Vectors, differentiation of vector, rules- Gradient of scalar field, Divergence and curl of a vector field, Vector relationship- div V and crul V in terms of curvilinear coordinates- div V in cylindrical and spherical coordinates, ∇^2 in cylindrical and spherical coordinates- Vector integration- line, surface and volume-Gauss, stokes greens theorem.

Linear vector space: Linear dependence and independence- Dimension, Basis, Change of basis- Subspace, Isomorphism- Linear operators. Matrix representative of a linear operator, Invariant subspace. Eigen values and eigenvectors.

12 hrs

Unit 2:

Matrices: Orthogonal, Hermitian, and unitary matrices-eigenvectors and eigenvalues- diagonalization of matrices- Matrix representation of linear operators- eigenvalues and eigenvectors of operators-simultaneous eigen vectors and commutativity- applications to physical problems.

Tensors: Tensors, contravariant and covariant tensors- symmetric and anti-symmetric tensors- Tensor algebra : equality, addition and subtraction, tensor multiplication, outer product; contraction of indices, inner product, quotient theorem, Kronecker delta, metric tensor**,** Christoffel symbols.

12 hrs

Unit 3:

Special functions: Helmholtz equation in cylindrical and spherical polar coordinates. Differential equations: Regular and irregular singular points of a second order ordinary differential equation. Series solutions–Frobinius method. Linear independence of solutions-Wronskian.

Hermite functions: Generating functions, Recurrence relations, Rodrigues representation, Orthogonality- *Laguerre functions:* Differential equation-Laguerre polynomials, Generating function, Recurrence relations, Rodrigues representation, Orthogonality-. *The gamma function and beta function*; definition, simple properties and problems.

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, arrays, functions and programming examples in C.

Discussion on writing programs for the mathematical problems listed in laboratory activates.

12 hrs

References:

1. Mathematical methods for physicists, Arfken G. B and Weber H.J, 4th Edition, Prism Books Pvt Ltd, India (1995).

2. Mathematical Physics, Sathya Prakash, Sultan Chand and Sons, (1985)

3. Mathematical Physics, Chattopadhyaya P.K, Wiley Eastern, (1980)

4. Methods of Mathematical Physics, Bose H.K and Joshi M.C, Tata McGraw Hill, (1984).

5. Vector Analysis, Murray R Spiegel, Schaum's Outline Series, McGraw Hill International Book Company, Singapore (1981).

6. Tensor Analysis — Theory & Applications. Sokolnikoff LS, 211:i Edition, John Wiley & Sons (1964).

7. Mathematical Methods in the Physical Sciences, Mary L. Boas, 2nd Edition, John Wiley & Sons (1983)

8. C-Programming Language, Balaguruswamy E, Tata McGraw Hill (1999)

9. C-Programming Language, Xavier C, New Age International (2000)
10. Mathematical Physics, B .S .Rajput, Pragati prakashan (2015)

CPT 1.3: ELECTRONIC DEVICES, COMMUNICATION AND EMBEDDED SYSTEM

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

Unit 1:

Transistors: Biasing, Need for biasing**,** Methods of biasing-fixed bias, collector to base bias and voltage divider bias, DC and AC load line, Transistor small signal amplifiers: Single stage and multistage amplifier, frequency response, Push-pull amplifier, Multivibrators: Astable and Bistable, Voltage regulator using transistors.

Thyristors: Types of thyristors, Working and characteristics of SCR, TRIAC and UJT.

Operational amplifier: Parameters of an op-amp, Applications: Instrumentation amplifier, Square wave and sine wave generator, Active filters- First order Butterworth low pass and high pass filter.

12 hrs

Unit 2:

Optoelectronic devices: Principle and working 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, Block diagram of super heterodyne receiver.

Optical fibre communications: The general system, Advantages of OFC, Optical fibre wave guide, Theory of transmission: total internal reflection, acceptance angle, numerical aperture, Preparation techniques of optical fibres, Optical fibre connectors, Fibre splices.

12 hrs

Unit 3:

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

Sequential circuits: Latches, Flip-flops, SR, JK- Flip-flop, JK Master-Slave, D, T flip-flops, counters, synchronous and asynchronous counters, ripple counters, registers, shift registers. **A/D and D/A conversion circuits:** Introduction, filtering and sampling, quantization, quantization error, Binary weighted converter, R-2R ladder converter.

12 hrs

Unit 4:

Embedded system: Introduction to embedded systems and general purpose computer systems, Architecture of embedded system, Classifications, Applications and purpose of embedded systems.

Basics of microprocessor: Architecture of 8085, addressing modes, Instruction set, Timing diagrams, pins and signals, Memory read and I/O read, Memory write and I/O write, Memory organization.

Basics of microcontroller:, Architecture of 8051, Pin description, Memory organization, Addressing modes, Instruction set, Interfacing and industrial applications of microcontrollers: 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. Semiconductor Optoelectronic Devices, Pallab Bhattacharya, Pearson education.
4. Electronic Principles, A P Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
5. A Text Book of Basic Electronics, RS 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. Digital principles and applications, Donald P Leach and Albert Paul Malvino, Tata McGraw Hill.
11. Digital Fundamentals, Floyd and Jain, Pearson Education.
12. Digital Electronics: Principles and Integrated Circuits, Anil K. Maini, Wiley India Edition.
13. Fundamentals of Microprocessors and Microcontrollers, B Ram, Dhanpat Rai Publications.
14. Embedded Systems: Architecture, Programming & Design, R. Kamal, Tata McGraw Hill.
15. 8051 Microcontroller: Hardware, Software and Applications, V. Udayashankara and M. S Mallikarjuna swamy, Tata McGraw Hill.

SPT 1. 4A: CONDENSED MATTER PHYSICS-I (Special)

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

Unit 1:

X-ray crystallography: The Lattice, unit cell, Seven crystal systems, Fourteen Barvais lattice, Hexoganal, Trigonal and Rhombohedral systems- X ray, interference by one dimensional lattice, Laue equation-Lattice plane and *hkl*-indices. Bragg equation and quadratic Bargg equation.

The concept of Direct to reciprocal lattice and supporting theorems- Ewald construction- Atom form factors- Atom displacement form factors-structure Factors.- Simple symmetry in crystals-Coupling and combination of symmetry elements. The space group-notations and analysis.

Unit 2:

Experimental techniques: Film method: Rotation and Weissenberg method- Powder and Counter methods. Principles of X-ray powder diffraction method, interpretation of powder photographs. The single crystal difractometer (Architecture).

Electron and neutron diffraction: Basic principles. Differences between them and X-ray diffraction. Applications (qualitative).

Crystal growth: Crystal growth from melt and zone refining techniques. Liquid crystals: Morphology. The smectic (A-H), nematic and cholesteric phases. Birefringence, texture and X-ray studies in these phases. Orientational order and its determination in the case of nematic liquid crystals.

Crystal lattice dynamics: Vibration of an infinite one-dimensional monatomic lattice, First Brillouin Zone. Group velocity. Finite lattice and boundary conditions. Vibrations of a linear diatomic lattice-optical and acoustical branches; relation.

12 hrs

Unit 3:

Magnetic properties of solids: Diamagnetism and its origin. Expression for diamagnetic susceptibility. Paramagnetism- Quantum theory of Paramagnetism. Brillouin function.

Superconductivity: Experimental facts. Type I and type II semiconductors. Phenomena logical theory. London equations. Meissner effect. High frequency behavior. Thermodynamics of superconductors. Entropy and Specific heat in the superconducting state. Qualitative ideas of the theory of superconductivity.

12 hrs

Unit 4:

Semiconductors: Intrinsic Semiconductors. Crystal structure and bonding. Expressions for carrier concentrations. Fermi energy, electrical conductivity and energy gap in the case of intrinsic semiconductors. Extrinsic Semiconductors; impurity states and ionization energy of donors. Carrier concentrations and their temperature variation. Qualitative explanation of the variation of Fermi energy with temperature and impurity concentration in the case of impurity semiconductors.

Semiconductor devices: Brief discussion of the characteristics and applications of phototransistors, JFET, SCR and UJT.

References

1. Stout G.H. and Jensen L.H., X-ray structure determination, MacMillan, USA, 1989.
2. Ladd M.F.C. and Palmer R.A., Structure determination by X-ray crystallography, Plenum Press, USA, 2003.
3. Buerger M.J., Elementary crystallography, Academic Press, London.
4. Dekker A.J., Solid state physics, Prentice Hall, 1985.
5. Kittel C., Introduction to solid state physics, 7th Edn., John Wiley, New York, 1996.
6. Mckelvey J.P., Solid state and semiconductor physics, 2nd Edn., Harper and Row, USA, 1966.
7. Streetman B.G., Solid state electronic devices, 2nd Edn., Prentice-Hall of India, New Delhi, 1983.
8. De Gennes P.G. and Prost J., The physics of liquid crystals, 2nd Edn., Clarendon Press, Oxford, 1998.
9. Wahab M.A., Solid state physics, Narosa Publishing House, New Delhi, 1999.
10. Azaroff L.V., Introduction to solids, McGraw-Hill Inc, USA, 1960.
11. Pillai S.O., Solid state physics, New Age International Publications, 2002.

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 co efficients- 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 behavior- the model as a parameter in design- rubber like elasticity-anelastic behavior – viscosity behavior. 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** (1975).
2. Material science and engineering, **V. Raghavan**, Prentice Hall (1993)
3. Nature of chemical Bond, **L Pauling**, Oxford and IBH (1960)
4. An introduction to crystallography, **F.C. Phillips**, Longman (1970)
5. Crystallography applied to solid state physics, **Verma and srivastava** New age international (2005)
6. Introduction to solid Solid state physics**, C. kittel,** Wiley Eastern (1993)
7. The structure and properties of Materials vol I- IV- **Rose, Shepard** and wulff (1987)
8. Introduction to solids**, L. V Azaroff, Mc Graw** Hill (1977).
9. Foundation of material science and engineering, William **F. Smith,Mc** Graw Hill international Editions (1988).
10. Solid state Physics Source Book**- Sybil P Parker** (Ed), Mc Graw Hill (1987)
11. Solid state phase trasformations, **V. Raghavan**, Prentice hall (1991)

LABORATORY EXPERIMENTS

CPP 1.5 (1.1): General Physics

1. To determine the Diameter of the rupee coin using the methodology of scattering theory
2. To determine the Refractive index of the different glasses
3. Stefan-Boltzmann law of black body radiation
4. The shape of the hanging chain
5. To measure the Thermal conductivity of good conductor such as aluminium, copper, brass etc., by following Frobes method
6. Verification of Stefan – Boltzmann law by Electrical method for a filament bulb.
7. To determine acceleration due to gravity using Atwood's machine
8. To determine the Velocity of light by observing Jupiter moon
9. Anharmonicity of simple harmonic oscillator.
10. Study of rotational motion of rigid body on Oberbeck pendulum.
11. Michelson Interferometer
12. Hysteresis Loop (B – H Curve)

(More than Eight Experiments has to be performed).

CPP 1.6 (1.2): Computer programming –I

1. Program for determination of energy of electron in 1-D potential box in 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 laguree 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.

(More than Eight Experiments has to be performed)

CPP 1.7 (1.3): Electronics

1. Design and study of two stage RC –Coupled amplifier.
2. Design and study of Push-pull amplifier.
3. Design and study of Voltage regulator using Transistors.
4. Design and study of Astable Multi vibrator using Transistors.
5. Study of I-V Characteristics of Triac and use it as Phase control circuit.
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. Design and study of Integrator and Differentiator using Op-amp
9. Study of Characteristics of a Photo Transistor.

10. Simplification of Boolean expressions using Karnaugh map and their implementation using Ic's.
11. Half Adder and Full Adder.
12. Construction and study of SR, JK and JK master-slave flip-flops.
13. Study of R-2R Ladder D/A converter using Op-amp.
14. Study of AM modulation and Demodulation.
15. Study of Transistorized FM Modulator.
16. Programming on 8085 microprocessor: Addition, Subtraction, Multiplication and Division.
17. Interfacing experiments on 8051 microcontroller: 7 Segment Display and Temperature measurement.

(More than Eight Experiments has to be performed)

SPP 1.8 A (1.4.1): Condensed matter Physics – I (Special)

1. Determination cell parameters for a X-ray powder Diffractogram
2. Drawing Brillouin zones for crystal lattices.
3. Exact calculation and Born-Oppenheimer approximation for vibrations of diatomic molecules
4. Fermi energy of copper
5. Determination of a size of amorphous material using optical method.
6. Characteristics of Photo transistor and Photodiode.
7. Characteristics of using SCR
8. Paramagnetic susceptibility by Gouy's balance method.
9. Thermal conductivity of bad conductor by lees method.
10. Experiment with Silicon solar cell
11. Structure analysis of Powder XRD data using Fullprof software.
12. Thermal conductivity Forbes method
13. Verification of Stefan's law

(More than Eight Experiments has to be performed)

SPP 1.8 B (1.4.2) : 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.

SEMESTER-II

CPT 2.1: QUANTUM MECHANICS – I

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

Unit 1:

Wave Mechanics: Matter waves, phase and group velocity concept of De Broglie wave length. Double slit experiment-Postulates of quantum mechanics- Uncertainty principle for canonical conjugate pairs, illustration, modified uncertainty relation and its applications, Commutators-Concept of wave function and limitations- Superposition principle- Eigenvalues and eigenvectors and its properties-Operators: momentum, kinetic energy, Hamiltonian-Normalization of a wave function-probability density-expectation values-Concept of Schrodinger equation-Probability current density-Orthogonal and orthonormality- Position and momentum representations of a wave functions. Ehrenfest's Theorem and continuity equation.

12 hrs

Unit 2:

Matrix Mechanics: Linear vector space, Matrix representation of operators and wave function, unitary transformation, tensor products- representation of Schrödinger equation, Linear Harmonic oscillator, Particle in a box in matrix form- Dirac Bra-Ket notation- Eigenvalues and eigenvectors and its properties in terms of Dirac notation and matrix representation. Schrödinger, Heisenberg and interaction picture of equation of motion.

12 hrs

Unit 3:

Theory of Angular momentum: Orbital angular momentum and their Algebra. Eigen functions and eigenvalues of L^2 and Lz using Schrodinger wave mechanics and matrix mechanics.- Stern-Gerlach experiment -Physical picture of spin, components of spin operator, Expectation values of S_z and S, Spin states of an electron- Spin orbit coupling, Spintronics- Addition of angular momentum, Clesch-Gorden coefficients.

12 hrs

Unit 4:

Bound states and Unbound states:: Particle in a 1D and 3D-box- Simple Harmonic Oscillator wave function and operator approach.-Rigid rotator-hydrogen atom.-Two-particle bound state problems, reduction to a one-particle problem.

Rectangular potential well and barrier, Tunneling, Transmission and Reflection co-efficient. Ramsauer -Townsend effect, Alpha decay, cold emission of electron in a metal.

12 hrs

References:

1. E. Merzbacher, Quantum Mechanics. 3rd edition, John Wiley (1994).

2. V.K. Thankappan, Quantum Mechanics, Wiley Eastern (1985).

3. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, TMH (1977).

4. R.L.Liboff, Introduction to Quantum Mechanics, Pearson Education (2003).

5. R. Shankar, Principles of Quantum Mechanics,2nd edition, Plenum US (1994).

6. A Ghatak and S Lokanathan, Quantum Mechanics, Theory and Applications, Macmillan (2004)

7. LI Schiff, Quantum Mechanics, 3rd ed. McGraw-Hill (1968).

8. J.J. Sakurai, Modern Quantum Mechanics, Addison Wesley (1985).

9. B.Bransden, C.Joachain, Quantum Mechanics, 2nd ed, Pearson/Prentice Hall, (2000).

10. J.S.Townsend, A Modern Approach to Quantum Mechanics, 2nd ed, McGraw Hill.

11. C.Cohen-Tannoudji, B.Diu, F.Laloe,Quantum Mechanics (2 vol. set),Wiley Inter science (1996)

12. S. Rajasekar, R.Velusamy, Quantummechanics I, Taylor& Francis Group (2015).

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, its application to the Peltier effect and Seebeck effect.

12 hrs

Unit 2:

Classical statistical mechanics: fundamental postulates, The Liouville theorem; the 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: The postulates of quantum statistical mechanics. The density matrix, The Liouville theorem in quantum statistical mechanics; Ensembles in quantum mechanics; microcanonical ensemble, canonical ensemble, Grand canonical ensemble. Symmetry of wave functions. The quantum distribution functions; Bose-Einstien distribution , Fermi –Dirac distribution. Boltzman 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, 2000.
2. Roy S.K., Thermal physics and statistical mechanics, New Age International Pub., 2000.
3. Huang K., Statistical mechanics, Wiley-Eastern, 1975.
4. Laud B.B., Fundamentals of statistical mechanics, New Age International Pub.,2000.
5. Schroeder D.V., An introduction to thermal physics, Pearson Education New Delhi, 2008
6. Salinas S.R.A., Introduction to statistical physics, Springer, 2004.

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

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

Unit 1:

Ferromagnetism : Review of Weiss theory of ferromagnetism-Heisenberg exchange interaction, =, Ising model, Spin waves (one dimensional case only), quantization of spin waves and magnons, density of modes, thermal excitation of magnons and Bloch T 3/2 law, specific heat using spin wave theory. Band theory of ferromagnetism. - Hysteresis curve, magnetocrystalline anisotropy energy, Bloch wall.

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

Ferrimagnetism: Ferrimagnetic order, ferrites, Curie temperature and susceptibility of ferrimagnets.

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 catatrophe. 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 (1965)
2. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
3. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore

(1976)
4. Elementary Solid State Physics : M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi (2000)
5. Introduction to Magnetic Resonance: A. Carrington and A. D. Mclachlan, Harper & Row, New York, (1967).
6. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009).

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 andtypes of metals, Electronic properties of metals- electrical and thermal conductivity, Widemann- 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- Subiattice mode|~ 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 (1974)

2. Elements of Materials Science and Engineering**- L H Van Vlack,** Addison Wesley (1975)

3. Introduction to solid state Physics,C. **Kittle,** Wiley Eastern (1993)

4. Solid State Physics, **A. J. Dekker,** Mc Milan India (2005)

5. Introduction to solids, **L V Azaroff ,** Mc Graw Hill (1977)

6. Electronic Materials, **S. Muraka ,** Academic Press (1989)

7. Superconductivity and Superconducting Materials**- A. V. Narlikar and S. N. Ekbote,** South Asian Publications (1983)

8. Semiconductor Physics**- P S Kireev,** Mir Publishers (1975)

9. Solid State and semiconductor Physics, **John Mckelvey,** Harper and Low (1969)

10. Modern Magnetism**- L F Bates,** Cambridge University Press(1963)

11. Electronic Properties of Materials **Ver, Hummel,** Springer lag (1985)

12. Physics of dielectric Materials**- *13* Tareev,** Mir Publishers (1979)

13. Magnetic Resonance**- C P Slichter ,** Harper and Row (1985)

14. NQR Spectroscopy, SSP Suppl. **I T P Das and E. L. Hahn,** Academic Press (1957)

15. Mossbauer Effect and its Applications, **V G Bhide,** Tata McGraw Hill (1973)

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; the 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; the 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: 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; the Hydrogen bond; 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; the quantum view point.
Lasers: Absorption, Spontaneous and Stimulated emissions; Population inversion; 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. The liquid drop model. Radioactivity**:** Decay constant**,** Half-life**.**

Relativity: The Michelson-Morely experiment. Postulates of Special theory of Relativity; Time dilation; Length contraction; Simultaneity of events; $E = mc^2$.

12 hrs

References:

1. Modern Physics (2nd Ed) Serway, Moses and Moyer, Saunders College Pub, 1997.
2. Fundamentals of Physics extended with Modern Physics (4th Ed) Halliday, Resnick and Walker, John Wiley, 1993.
3. Concepts of Modern Physics by Arthur Beiser, Mcgraw- Hill Higher education, 2003.

LABORATORY EXPERIMENTS

CPP-2.5 (2.1): 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.
8. Absorption Co-efficient of a solution.
9. Elliptically polarized light.
10. Edser-Butler fringes.
11. Lattice dynamics of Mono and Diatomic lattice.
12. Laser diode characteristics.
13. Determination of L of a coil by Anderson's method

CPP-2.6 (2.2): 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.

SPP-2.7.1 (2.3.1): Condensed Matter Physics-II

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 constants.
4. Magnetic Hysteresis
5. Energy gap of a Semiconductor

6. Determination of paramagnetic susceptibility of a given salt by Quinckes method.
7. Determination of Hall coefficients and estimation of charge carrier concentration
8. Lattice Excitation of X-ray Diffraction
9. Laser induced Fluoresence of I_2
10. Determination of Lande's factor of DPPH using ESR Specrometer
11. Study of Faraday effect using He-Ne Laser
12. Basics of P-N Junction –Diffusion current, Drift current, Junction width, forward and reverse biasing, Significance of Fermi level in stabilizing the junction.
13. UJT Characteristics and oscillator

(More than Eight experiments)

SPP-2.7.2 (2.3.2): 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.

OEPT– 2.8 (2.4): Modern Physics

1. Analysis of Raman Spectrum of N_2 molecule
2. Analysis of Rotational –Vibrational Spectrum
3. Wavelength of Laser
4. Stefan-Boltzman's Law (Electrical method)
5. Stellar Spectra
6. Determination of Rydbergs Constant
7. Determination of Planck's Constant
8. Refractive Index of glass
9. Experiments with LEDs
10. Verification Inverse Square Law by Gamma Radiation
11. Michelson Morley experiment
12. Experiments with LDR

SEMESTER-III

CPT 3.1: QUANTUM MECHANICS –II

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

Unit 1:

Symmetry in quantum mechanics: Symmetry and Invariance principle: Time and conservation of energy, Spatial transition and conservation of linear momentum**,-** parity transformation and time reversal invariance. -Permutation symmetry, symmetric and anti-symmetric wave functions, the exclusion principle, slater determinant.-Excited states of helium atom: *ortho* and *para* states of helium atom- Collision between identical particles.

12 hrs

Unit 2:

Approximation method I: Time independent perturbation theory: For non-degenerate states, Applications to Perturbed linear harmonic oscillator and ground state of hydrogen atom, hyperfine splitting- Degenerate perturbation theory, first order stark effect in hydrogen atom, normal Zeeman effect.

Approximation method II: Time dependent perturbation theory: Time dependent perturbation series. Harmonic perturbation; transition probability, Fermi golden rule, Application to the particle in 1-D box and linear harmonic oscillator.-Semi classical theory of radiation, Calculations of Einstein coefficients.

12 hrs

Unit 3:

Approximation method III : Principal of WKB method, approximate solutions near turning pints, and connection formulae- Application to 1-D potential well, linear harmonic oscillator and Hydrogen atom.-Tunneling through a barrier.

Approximation method IV : The variational method: variation theorem, application of variation theorem (i) Hormonic oscillator (ii)Hydrogen atom and (iii) Helium atom.

Scattering theory: Centre of mass and laboratory coordinates, Scattering Amplitude, Born approximation, Validity for the Born approximation, Screened coulomb potential.

12 hrs

Unit 4:

Relativistic quantum mechanics: Klein Gordan equation for a free particle and its drawbacks; probability density. Dirac equation for free particle, properties of Dirac matrices, solutions of free particle Dirac equation- ortho normality and completeness, spin of the Dirac particle, negative energy sea, co variant form of dirac equation. Velocity operator of a free Dirac particle and Zitterbeagung.

Non relativistic limit of Dirac equation for a free particle moving in a central potential – spin -orbit energy. Dirac particle under the influence of a uniform external magnetic field – magnetic moment for the Dirac particle.

12 hrs

References:

1. Quantum mechanics, B.H. Bransden and Joachain, 2nd Edition Pearson Education (2004)
2. Introduction to Quantum mechanics, David J. Griffiths, 2nd Edition, Parson Education (2005)
3. Modern Quantum mechanics, J.J. Sakurai, Pearson Education, (2000)
4. Quantum mechanics, V.K Thankappan, 2nd Edition 2004
5. Quantum mechanics, Stephen Gasiorowicz, john Wiley (2003)
6. Relativistic Quantum mechanics and Relativistic Quantum fields, J.D. Bjorken and S.D. Drell, Mc. Graw-hill, New York (1968)
7. Quantum mechanics, L.ISciff,Mc. Graw-hill, (1955)
8. S. Rajasekar, R.Velusamy, Quantum mechanics I, Taylor& Francis Group (2015).

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 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 and four factor formula.

12 hrs

Unit 2:

Nuclear forces: characteristics of nuclear forces, short range, saturation, chare 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, and position sensitive detector

12 hrs

Unit 3:

Nuclear models and nuclear decay:

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.

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, 1971

2. Atomic and Nuclear Physics, S. N. Goshal vol II 2000

3. Introductory Nuclear Physics Kenneth S. Krane: John Wiely and Sons, 1987

4. The Atomic Nuclease Evans R.D. : Tata Mc. Graw hill, 1955

5. Nuclear Physics, R R Roy and Nigam: Wiley-eastern Ltd 1983

6. Nuclear physics an introduction, S.B. Patel: New age international (P) limited 2000

7. Radiation Detection and Measurements, G.F. Knoll: 3rd edition, John Wiely and sons, 2000

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, 2000.

9. Introduction to Elementary Particles, D.Griffiths: john Wiley1984

10. Nuclear Interactions, S.de Benedetti: John Wiley, New York, 1964.

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

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

Unit 1:

Disordered systems: Point defects-shallow impurity states in semiconductors-Localized lattice vibrational states in solids-Vacancies, interstitials in ionic crystals- Color centers in ionic crystals-Types of Color centers- methods of production-mechanism - Characteristic absorption bands, Properties of Color centers- Models and Applications.

Photoconductivity, Luminescence- fluorescence, Phosphorescence- Thermoluminescence, Photoluminescence, Electroluminescence; Mechanisms. Imperfections in crystals, Mechanism of plastic deformation in solids, Stress and strain fields of screw and edge dislocations, Elastic energy of dislocations.

12 hrs

Unit 2:

Disorder in Condensed Matter : Introduction- Short range order- 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- Atomic correlation function and 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 and in amorphous semiconductors- Applications.

12 hrs

Unit 3:

Semiconductors: Structure of typical semiconductors- Fermi energy expression in Intrinsic and extrinsic semiconductors- its variation with temperature and impurity concentration- Law of mass action- Charge neutrality equation- mobility- diffusion- generation- recombination of Carriers in Semiconductors- Conductivity equation- carrier Life time- Haynes-Shockley experiment- Hall effect in semiconductors- Determination of dell coefficient in intrinsic, n-type and p-type semiconductors.

Devices: Fabrication of devices- by growth, alloying. diffusion, ion implantation method. MS and SS contacts- energy band diagrams- Contact potentials- Rectification. Artificial structures: Supper lattice, conversion layers.

12 hrs

Unit 4:

Films and Surfaces : Thin films Methods of preparation: Thermal evaporation- sputtering- DC, AC, diode, triode, magneton, ion beam sputtering, Laser and electron beam evoparation technique. Chemical vapor deposition. Characterization of thin films- film thickness: optical methods-interferometry- 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 frobe method, thin film resistors (Conduction in metal and non-metallic films) Magnetic properties- film size effect on MS- films for memory devices.

12 hrs

References:

1. Solid State Physics, A. J. Dekker, McMillan India Ltd, 2003.

2. Luminescence of Solids, D. R. Vij, Plenum Press, 1998.

3. Elementary dislocation theory, J. Weertman and J.R. Weertman, New York ; Macmillan 1964

4. Crystallography Applied to Solid State Physics, Verma and Srivasthava, 2nd Edition. New age International publishers, 2001.

5. Introduction to Solid State Physics, C. Kittel, 7"‘ Edition, John Wiley and Sons 1996.

6. Thin Film phenomenon, K.L. Chopra, McGraw Hill Book Company, 1969.

7. Introduction to solid state theory**,** Otfried Madelung, Springer series. 1996.

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-weight, number and 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- inoulcling-compression, injection blow, extrusion, spinning.

12 hrs

Unit 2:

Ceramics and Glasses: 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- fibers, 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 fiber composites, wood-plastic composites, dispersion strengthened. Particle reinforced, fiber and laminate reinforced composites with fabrication, interface, properties and applications.

12 hrs

Unit 4:

Testing of Materials : Mechanical Testing - Universal Testing Machine. Hardness- Brinnel, 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 8. Sons, Inc. (1984)
2. Polymer Science, **V.R. Gowariker, N. V. Vistrwanathan, Jayadev Shreedhar**, Wiley Eastern (1937)
3. Electronic properties of Materials**- Rolf E. Hummel, Springer Verlag**, Springer Verlag (1985)
4. Foundations of Materials Science and Engineering**- William F. Smith**, McGraw Hill international Editions, (1988)
5. Elements of Materials Science and Engineering. Lawrence **H. Van Vlack,** Addison Wesley (1975)
6. Introduction to Ceramics**- W D Kingery, H K Bower and U R Uhlman,** John Wiley (1960)
7. Ultrasonic **B. Carlin** , Mc. Graw Hill (1950)
8. Principles of Neutron Radiography**- N D Tyufyakav and A S Shtan** , Amerind Publishers (1979)
9. Applied X-rays**- George L Clark**, Mc. Graw Hill, (1955)
10. Testing of Metallic Materials**— AVK Suryanarayan** , Prentice Hall India, (1990)
11. Physical Metallurgy Part I, **R W Cahn and P Haasen** (Ed), North Holland (1983).

OEPT – 3.4: NANOSCIENCE AND NANOTECHNOLOGY

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

Unit 1:

Basics of nano science: The nanoscale, historical background, quantum confinement, size dependent properties, surface to volume ratio.
Basic quantum mechanics: Wave-particle duality, Heisenberg uncertainty principle Schrödinger equation --solution of one-dimensional time-independent equation, particle in a one- dimensional box; density of states for zero-, one-, two- and three-dimensional box; particle in a coulomb potential. Tunneling of a particle through potential barrier

12 hrs

Unit 2:

Synthesis of nanomaterials: Synthesis and nanofabrication, Bottom-Up and Top-Down approach with examples. Chemical precipitation methods, sol-gel method, chemical reduction, Physical methods- mechanical-ball milling, melt mixing; RF sputtering, Physical Vapour deposition (PVD), chemical vapour deposition, molecular beam epitaxy. Chemical methods: colloidal synthesis and capping of nanoparticles.

12 hrs

Unit 3:

Characterization techniques: microscopes - optical, SEM, TEM, STM, AFM; diffraction techniques -XRD, EXAFS neutron diffraction; spectroscopes --UV-visible-IR absorption, FTIR, Photoluminescence

12 hrs

Unit 4:

Properties of nanomaterials: Mechanical; Electrical --classification - metals semi-conductors, insulators, band structures; mobility, resistivity, Hall effect, magneto- resistance; Optical -- optical absorption and transmission, photoluminescence.

12 hrs

References:

1. Nanotechnology: Principles and practices, S. K Kulkarni, Capital Publ. Co., New Delhi (2007)
2. Nanocrystals : Synthesis, Properties and Applications, C.N.R.Rao, P. John Thomas and G.U. Kulkarni, Springer series in Materials Science 95, SpringerVerlag, Berlin, Heidelburg (2007).
3. Quantum Mechanics – Vol 1 & 2, Cohen, Tannoudji
4. The Physics and Chemistry of Solids, Stephen Elliot & S.R. Elliot
5. Solid State Physics- A.J. Dekker
6. Introduction to Nanotechnology- Charles P.Poole Jr and Franks J. Owens
7. Electronic Transport in macroscopic systems, Supriyo Datta
8. Nanotubes and Naowires- CNR Rao and A Govindaraj, RCS Publishing.
9. Encyclopedia of Nanotechnology- Hari singh Nalwa

LABORATORY EXPERIMENTS

CPP 3.5 (3.1): Modern Physics-II

1. Indexing powder XRD Pattern by analytical method.
2. Determination of energy band gap of nano powder using UV-Vis spectrograph
3. Determination of Magnetoresistance of semiconductors.
4. Preparation of nanoparticles by Sol-gel method.
5. Preparation of nanoparticles by solution combustion method.
6. Determination of mobility and charge carrier concentration using Hall apparatus.
7. Resistivity measurement of a semiconductor thin film by four probe method.
8. Temperature co-efficient of resistance of copper.
9. Analysis of Thermo luminescence glow curve.
10. Determination of nano particle size by Scherrer equation.
11. Determination of nano particle size using SEM image.
12. Structure factor calculation of simple crystal structures.
13. Analysis of XRD film using travelling microscope.
14. Determination of line broadening and particle size by Williamson-Hall plot of a powder XRD data.
15. Thin film deposition by spray pyrolysis and to study its UV-VIS response.

CPP-3.6 (3.2): 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 (NaI) 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.

SPP-3.7.1 (3.3.1): A Practical: Condensed Matter Physics –III (Special)

1. Michelson Interferometer
2. Determination of q, n, b by hyperbolic fringes method
3. Determination of q, n, b by elliptical fringes method
4. Determination of the thickness of a given transparent plate with the help of JAMIN'S INTERFEROMETER
5. Study of LISSAJOUS FIGURES and calibrate an Audio Frequency Oscillator by Phase change and direct method
6. Computation of density of states in tight binding model for 1,2 and 3-D lattices.
7. Computational verification of the validity of local density approximation for a harmonically trapped gas.
8. Determination of k/e using a transistor
9. Temperature Coefficient Of Resistance Of Copper
10. Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material
11. Dipole moment of an organic molecule
12. Analysis of thermo luminescence glow curve.

SPP-3.7.2 (3.3.2): 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 FeCl4 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_2O3 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.

OEPP-3.8 (3.4) Nanoscience and Nanotechnology

1. Analysis of X-Ray diffraction photograph of single crystal using Bernal chart.
2. Determination of crystallite sizes of Zno nanoparticles.
3. Determination of crystallite sizes of Cuo nanoparticles.
4. Determination of optical constants η and K using the transmission data of ZBV thin film
5. Determination of optical constants η and K using the transmission data of VZP thin film.

6. Determination of optical constants η and K using the absorption data of MgO nanoparticles.
7. Determination of optical constants η and K using the absorption data of NiO nanoparticles.
8. Analysis of X-Ray diffraction photograph of NaCl
9. Analysis of X-Ray diffraction photograph of KCl.
10. Analysis of T.L. glow curve of ZnO nanoparticles by deconvolution method.

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.

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.

Plasma Physics: Plasma, Debye shielding, Plasma oscillations Fluid description Mass conservation - continuity equation, Momentum conservation - motion (Euler) equation Energy conservation. magneto hydrodynamics, magnetic confinement-Pinch effect.

12 hrs

References:

1. Classical Electrodynamics: J.D.Jackson , Wiley Eastern Ltd., Bangalore (1978)
2. Introduction to Electrodynamics: D.J.Griffiths, Prentice Hall of India, Ltd., New Delhi (1995).
3. Electromagnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore (1987)
4. Classical Electromagnetic Radiation: J.B. Marion, Academic press, NewYork (1968).
5. Classical Electrodynamics; S P Puri, Tata McGraw –Hill Publishing Company Ltd., New Delhi, (1990).

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: Quantum states, Atomic orbitals, spectrum of hydrogen, Rydberg Atoms (brief treatment), Relativistic corrections to spectra of alkali atoms: Spin-orbit interaction and fine structure in alkali spectra. Lamb shift in hydrogen (qualitative Discussion only) Two electron atom: Ortho and Para states and role of Pauli principle, level schemes of two electron atoms. Perturbations in the spectra of one and two electron atoms: Zeeman effect, Paschen- Back effect, Stark effect in hydrogen spectra. Hyperfine interactions and 21cm line of hydrogen. Many electron atoms: Central field approximation. LS and JJ coupling schemes, Multiplet splitting and Lande interval rule.

12 hrs

Unit 2:

Molecular Physics A: Brief treatment of chemical bonds: covalent, ionic, Van der waal's interactions. The Born-Oppenheimer approximation (qualitative treatment), diatomic molecule as a rigid rotator, rotational spectra of rigid and non-rigid rotator, intensities of rotational lines. Microwave spectroscopy- principle and technique Types of rotors: Eigenvalues of Linear, Symmetric top, Asymmetric top and Spherical top molecules. Raman spectroscopy: Theory of Raman effect, experimental techniques, rotational Raman spectra of diatomic and linear polyatomic molecules.

12 hrs

Unit 3:

Molecular Physics B: Diatomic molecule as a simple harmonic oscillator, anharmonicity, Morse potential curves, vibrating rotator: energy levels and vibration spectra, PQR branches in rovibronic spectra , experimental technique and IR spectrometer. Comparison of vibration and Raman spectra.

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.

12 hrs

Unit 4:

Optical Physics: Coherence of light, spatial and temporal coherence, Einstein's Coefficients: spontaneous and stimulated emission, idea of light ampiification, characteristics of a laser beam, threshold condition for laser oscillation, role of resonant cavity, He-Ne lasers, Brief treatment of application of lasers.

Holography: Fundamentals of 3D»mapping of images, recording and reconstruction, applications in microscopy and interferometry.

Fiber optics: Mechanism of light propagation in a fiber wave guide, numerical aperture, types of optical fibers, transmission characteristics of optical fibers—attenuation and dispersion, optical fiber communication system (qualitative).

12 hrs

References:

1. Physics of atoms and molecules, Bransden and Joachain, (2nd Edition) Pearson Education, 2004

2. Introduction to Atomic Spectra, H E White, McGraw Hill Kogakusha Ltd.

3. Fundamentals of Molecular Spectroscopy, Banwell and Mccash, Tata McGraw Hill, 1998.

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, 1998.

6. Molecular Quantum Mechanics, P.W. Atkins and R.S. Friedman. Third Edition, Oxford Press(Indian Edition), 2004

7. Lasers, Silfvast, Cambridge Press,1998

8. Lasers, Nambiar, New Age International, 2004

9. Optical Electronics, Ghatak and Tyagarajan, Cambridge Press, 2004

10. Lasers and Nonlinear Optics- B.B. Laud, Wiley-Eastern Ltd. 1991.

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

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

Unit 1:

Reciprocal lattice: Elementary considerations, graphical construction, vector algebraic discussion, relation between direct and reciprocal cells, interpretation of Bragg's law using reciprocal lattice concept, general spacing formula, transformation equations and their importance.

12 hrs

Unit 2:

The Laue method: Reciprocal lattice construction, instrumentation, flat plate cameras, front reflection region, appearance of photographs, back reflection region, appearance of photographs. Rotating crystal methods: Reciprocal lattice construction, instrumentation, cylindrical camera, mounting and adjustment of crystal, interpretation of photographs, unit cell determination, indexing procedure.

12 hrs

Unit 3:

Moving film methods: Weissenberg method, reciprocal lattice construction for zero level and higher levels, indexing procedure, interpretation of photographs. Single crystal diffractometer: Reciprocal lattice construction, para focussing and goniometry, intensity measurements.

12 hrs

Unit 4:

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, characteristics of powder pattern lines, application to identification of solid solution and phase changes, line broadening and particle size measurements, interpretation of powder photographs of unknown system, powder diffractometer and applications.

12 hrs

References:

1. Elements of X-ray Crystallography, L.V. Azaroff: McGraw Hill, New York, 1968.
2. An introduction to Crystallography, Michael M Wooffen: Cam bridege University Press, 1997
3. Crystal growth Processes and methods, Santhana Raghavan and Ramaswamy: KRU Publications, Kumbakonam.
4. Crystallography for solid state physics, Verma and Srivastava: New age international Ltd. 1997.
5. Solid State Physics, Charles Kittel: Wiley Eastern, 1984.
6. X-ray crystallography, M.J.Burger: John Wiley, New York, 1952.
7. Crystalline Solids, Duncan M and C. Mike: Nelson, London, 1973.
8. The powder method in X-ray cryst. L.V. Azaroff and M.J.Burger: McGraw Hi11,1958.

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 & nonmetals-Luminescence, photoconductivity.

12 hrs

Unit 2:
Electrical properties of crystalline, nanocrystalline and polymeric materials: Resistivity variation in metals, alloys, semiconductors and nanocrystalline 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 & strain, stress-strain behavior, elasticity, Plastic deformation, Hardness-Knoop & 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 & instruments: Static characteristics of instruments, accuracy & precision, sensitivity, reproducibility, errors, Transducers, classification & selection criteria, principles of piezoelectric, photoelectric, thermoelectric transducers, resistance temperature transducers (RTD), Thermister, strain gauge, load cells, LVDT Electronic instruments for measurement, Digital voltmeter, principles of electronic multimeter, digital multimeter, Q-meter, Electronic LCR meter, Frequency & time interval counters.

12 hrs

References:
1. Introduction to Ceramics by W. D. Kingery, H. K. Bowen and D. R. Uhlmann, John Wiley & Sons
SPT -4.3.C Nuclear Physics-IV
2. Diffraction analysis of the microstructure of materials by E. J. Mittemeijere and P. Scardi, Springer
3. Materials Science & Engineering by William D. Callister, John Wiley & Sons, Inc.
4. Modern techniques of surface science by D. P. Woodruff & T. A. Delchar, Cambridge University Press
5. X-ray spectroscopy by B. K. Agarwal, Springer-Verlag.

CPD- 4.4: Core Paper Dissertation

LABORATORY EXPERIMENTS

CPP-4.5 (4.1): Modern Physics-III

1. Study of magnetic field along the axis of a current carrying circular coil and its dependence on coil diameter and number of turns.
2. Study of skin effect on wire.
3. Determination of e/m by Millikan's oil drop method.
4. To calculate the beam divergence and spot size of the given laser beam.
5. Temperature dependence of the resistivity of a metal.
6. Determination of refractive index by Brewster angle measurement/Malus law.
7. Ultrasonic wave velocity in a liquid medium.
8. Determination of wavelength of sodium light using Fresnel biprism.
9. Solution to Laplace's equation using method of relaxation
10. Determination of Solar constant and Sun's surface temperature.
11. Experiments on Bremsstrahlung.
12. Verification of Faraday and Lenz's law induction
13. Study reflection and refraction of electromagnetic waves
14. Study of circular or elliptical polarization of electromagnetic wave.
15. LDR characteristics.
16. Verification of Malus law
17. Indexing of non-cubic system.
18. X-ray powder analysis of Tungsten.
19. Determination of masses of spectroscopic binary system.
20. Determination of Solar rotation period.
21. Measurement of diameter of human hair and a wire.
22. Verification of Fresnel's law.
23. Determination of charge to mass ratio of electrons.
24. X-ray powder analysis of Copper.

CPP-4.6 (4.2): Atomic Molecular and optical Physics

1. Vibrational analysis of CN violet bands.
2. Determination of numerical aperture and bending loss of an optical fiber.
3. Franck Hertz experiment.
4. Study of vibrational Raman Spectra of Di-atomic 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. Investigation of Electron spin resonance spectrum for the given DPPH sample and determination of Lande's g factor.
13. Measurement of the wavelength of absorption bands of $KMnO_4$ and calculate its Hartmann constant.
14. Determination of Bire fringe's of mica using Babinet compensator.

SPP- 4.7 (4.3.1): Condensed Matter Physics –IV (Special)

1. Indexing powder XRD pattern by analytical method.
2. Structure factor calculation of simple crystal structures.
3. Finding accurate values of crystal parameters using FULLPROF software.
4. Finding accurate values of crystal parameters using Nelson-Reiley plots of a powder XRD data.
5. Determination of line broadening by Williamson-Hall plot and particle size by Scherrer's equation of a powder XRD data.
6. Analysis of single crystal XRD data.
7. Resistivity measurement of a thin film by four probe method.
8. Determination of energy band gap of a semiconductor using UV-Vis spectrograph.
9. Susceptibility of paramagnetic substance by Gouy's method.
10. Determination of Curie Temperature of a Ferromagnet.
11. Determination of Debye temperature by study of Specific heat of metals.
12. Temperature dependence of Susceptibility of a Paramagnetic substance.
13. Diffraction of X-rays: Laue's recordings, Debye Scherer's recordings, Bragg's reflection, Duane-hunt's displacement Law (h determination).
14. Investigation of the Conductivity behavior of NaCl and determination of the activation energy for Ionic conduction.
15. Finding accurate values of Crystal parameters using FULLPROF software.
16. Determination of Magneto resistance of Semiconductor.

SPP- 4.7 (4.3.2): 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 $CaSiO_3:Eu^{3+}$.

CPPP- 4.8: Core paper project practical

THEORY QUESTION PAPER PATTERN

Note: Answer any **five** questions. Question no. 1 is compulsory. **Max. Marks = 80**

1. Answer in one or two sentences (which includes all units) 8 X 2 = 16
    a.
    b.
    c.
    d.
    e.
    f.
    g.
    h.

Answer any **four** of the following questions:

2. Essay type question or 12
3. Essay type question or 12
4. Essay type question or 12
5. Essay type question or 12
6. Write short notes on any **four** of the following 4 X 4 =16
    a.
    b.
    c.
    d.
    e.

Internal marks for theory paper ***20 marks***

PRACTICAL QUESTION PAPER PATTERN

1. Experiments, Spotting, Demonstration 35 marks
2. Records and Viva-Voce 5 marks
3. Internal marks for practical 10 marks