

SEMESTER I

PCPHA20 – MATHEMATICAL PHYSICS – I

Year: I Sem: I	Course Code: PCPHA20	Title of the Course: Mathematical Physics – I	Course Type: Theory	Course Category: Core	H/W 6	Credits 5	Marks 100
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Course Objectives

1. To inculcate to the students the mathematical concepts for solving physical problems which arise in many branches of Physics
2. To prepare the students for solving the problems of mathematical physics in competitive examinations

Course Outcomes (CO)

The learners will be able to

1. Understand and apply the basic concepts of vectors and vector space.
2. Perceive various types of matrices, solve Eigen value problems and carry out matrix operations.
3. Solve ordinary differential equations that are common in the physical-sciences.
4. Understand the characteristics of special functions to solve the physical problems.
5. Understand and use Dirac-delta function for describing physical systems and apply Green's function to solve partial differential equations.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	H	M	H
CO2	H	M	H	M	H	H
CO3	H	H	M	H	M	M
CO4	H	H	H	H	H	H
CO5	H	M	H	M	M	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	M	H	H	H	H
CO5	M	M	M	M	M	H

(Low – L, Medium – M, High - H)

Course Syllabus

Unit I: Vector Analysis

(14 hours)

- 1.1 Vector Field - Orthogonal curvilinear co-ordinates - Expression for gradient, divergence, curl and Laplacian (K1,K2,K3)
- 1.2 Spherical and cylindrical coordinate systems - expression for gradient, divergence, curl and Laplacian(K2,K4, K5)
- 1.3 Stoke's theorem - Simple applications (K2,K3,K4,K5)
- 1.4 Gauss theorem - Simple applications (K2,K3,K4,K5)
- 1.5 Linear vector Space - Linear independence of vectors - Basis and Expansion theorem - Inner product and Unitary vector spaces (K2,K3,K4,K5)
- 1.6 Orthonormal sets - Schwarz inequality - Schmidt's orthogonalization method - Completeness (K2,K3, K4)

Unit II: Matrix Theory

(14 hours)

- 2.1 Introduction - Matrices - Transpose of a matrix - Conjugate - Conjugate transpose - Symmetric and Skew-symmetric matrices -Hermitian and Skew-Hermitian matrices - Unitary matrices (K1,K2)
- 2.2 Determinant- Co-factors - Minors of a matrix - Singular and non-singular matrices - Adjoint of a matrix - Inverse of a matrix- Orthogonal matrices - Unitary matrices (K2,K3,K4)
- 2.3 Characteristic equation of a matrix - Evaluation of Eigen values and Eigen vectors (K4, K5)
- 2.4 Cayley-Hamilton's theorem - Inverse of a matrix using Cayley Hamilton theorem (K3, K4, K5)
- 2.5 Important theorems on Eigen values and Eigen vectors (K2, K3, K5)
- 2.6 Stochastic matrices - Theorem on Stochastic matrix -Diagonalization of matrices(K2, K3, K4)

Unit III: Differential Equations

(16 hours)

- 3.1 Differential equations - Order and degree of a differential equation - Solution of first order differential equation by the method of separation of variables (K2, K3, K4, K5)
- 3.2 Solution of Linear differential equation of first order by the method of Integrating factor - Problems (K2, K3, K4, K5)
- 3.3 Solution of first order differential equation reducible to linear form (Bernoulli's equation) - Problems (K2, K3, K4, K5)
- 3.4 Solution of Second order differential equations with constant coefficients - Problems (K2, K3, K4, K5)
- 3.5 Power series solution: Frobenius' method
- 3.6 Linear independence of solutions: Wronskian method – Problems

Unit IV: Special Functions

(16 hours)

- 4.1 Series solution and Generating function of Bessel function(K2, K3, K5)
- 4.2 Orthonormal properties of Bessel - Evaluation of recurrence relations(K2, K3, K4, K5)
- 4.3 Series solution and Generating function of Legendre polynomial(K2, K3, K5)
- 4.4 Rodrigues formula and Orthogonal properties of Legendre Polynomial - Evaluation of recurrence relations(K2, K3, K4, K5)
- 4.5 Series solution and Generating function of Hermite polynomial(K2, K3, K5)

4.6 Rodrigues formula and Orthogonal properties of Hermite Polynomial - Evaluation of recurrence relations(K2, K3, K4, K5)

Unit V: Green's Function

(12 hours)

- 5.1 Dirac-delta function - Properties of Delta function - Problems - Fourier transform of Delta function - Laplace transform of Delta function(K1, K2, K4)
- 5.2 Green's function - Green's function for one-dimensional case (K1, K2, K4)
- 5.3 Evaluation of Green's function for boundary value problems (K1, K2, K4)
- 5.4 Eigen function Expansion of Green's function - Problem(K1, K2, K4)
- 5.5 Green's function for Poisson's equation and solution of Poisson's equation - Green's function for three dimensional Helmholtz equation(K1, K2, K4)
- 5.6 Green's function for Quantum mechanical scattering problem (K1, K2, K4)

Books for Study:

1. Sathyaprakash - Mathematical Physics - S.Chand& Sons, Reprint 2006.
2. B.D.Gupta- Mathematical Physics, 3rd Edition - Vikas Publishing House Pvt. Ltd., 2004.
3. E. Kreyszig - Advanced Engineering Mathematics, 8th Edition - Wiley, New York, 1999.
4. H.K. Dass - Mathematical Physics - S.Chand, Reprint 2007.

Books for Reference:

1. P.R. Halmos - Finite dimensional Vector Spaces, 2nd Edition - Affiliated East - West, New Delhi, 1965.
2. C.R. Wylie and LC. Barrett - Advanced Engineering Mathematics, 6th International Edition - McGraw Hill, New York, 1995.
3. P.K. Chakrabarti and S.N. Kundu - A Textbook of Mathematical Physics - New Central Book Agency, Kolkata, 1996.
4. A.K. Ghatak, I.C. Goyal and S.H. Chua - Mathematical Physics - Macmillan India, New Delhi, 2002.
5. M.D. Greenberg - Advanced Engineering Mathematics, 2nd Edition - International Ed., Prentice Hall International, New Jersey, 1998.
6. P.K. Chattopadhyay - Mathematical Physics - Wiley Esatern, Madras, 1990.
7. S. Lipschutz - Linear Algebra - Schaum's Series, McGraw Hill, New York, 1987.
8. G. Arfken and H.J. Weber - Mathematical Methods for Physics, 5th Edition - Harcourt (India), New Delhi, 2001.

SEMESTER I

PCPHB20 - CLASSICAL MECHANICS

Year: I Sem: I	Course Code: PCPHB20	Title of the Course: Classical Mechanics	Course Type: Theory	Course Category: Core	H/W 6	Credits 5	Marks 100
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Course Objectives

1. To make the students understand the different transformations that governs the classical mechanics.

Course Outcomes (CO)

The learners will be able to

1. Acquire knowledge about the fundamental concepts of dynamics of system of particles
2. Use D'Alembert's principle and calculus of variations to derive the Lagrange - Hamilton formalism applicable to solve the equation of motion for any mechanical system
3. Understand the essential features of canonical transformations and their applications to various systems.
4. Describe the Hamilton-Jacobi equation and develop the skills to use them to set and solve the appropriate physical problems.
5. Gain knowledge about the fundamental principles of small theory of oscillations and its applications.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	M	M	H	M
CO2	H	H	H	H	M	L
CO3	M	H	H	H	H	M
CO4	H	H	H	H	M	M
CO5	H	M	H	H	H	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	M	H	H	M	M
CO3	M	H	H	H	H	H
CO4	H	M	H	H	H	H
CO5	H	H	H	M	M	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Rigid Body Dynamics (16 Hours)

- 1.1 Introduction - Generalized coordinates of a rigid body - Body and space reference systems (K1, K2, K3)
- 1.2 Euler's angles - Infinitesimal rotations as vectors (K1, K2, K3)
- 1.3 Components of angular velocity - Angular momentum and Inertia tensor (K1, K2, K3)
- 1.4 Principle axes - Principle moments of inertia - Rotational Kinetic energy of a rigid body - Moment of inertia for different body systems (K1, K2)
- 1.5 Euler's equations of motion of rigid body - Torque free motion of a rigid body (K1, K2, K4)
- 1.6 Motion of a symmetrical top under the action of gravity (K4, K5, K6)

Unit II: Lagrangian and Hamiltonian Formulations (14 Hours)

- 2.1 Newton's equation and conservation laws for system of particles - Constraints (K1, K2)
- 2.2 Generalized co-ordinates - Principle of Virtual work (K1, K2)
- 2.3 D'Alembert's Principle - Lagrange's equation from D'Alembert's Principle - Procedure for formation of Lagrange's equation (K1, K2)
- 2.4 Kinetic energy in generalized coordinates - Lagrange's equation from Hamilton's Principle - Hamilton's equations (K1, K2, K3)
- 2.5 Δ variations - Principle of least action (K1, K2)
- 2.6 Applications (Atwood's Machine, Compound pendulum and LC circuit) (K3, K4, K5, K6)

Unit III: Canonical Transformations (13 Hours)

- 3.1 Introduction (K1, K2) - Canonical Transformations and their generators (K2)
- 3.2 Lagrange and Poisson Brackets notation (K2, K3)
- 3.3 Procedure for Applications of Canonical transformations - Condition for canonical transformations (K2, K3, K4)
- 3.4 Problems on canonical transformation (Simple Harmonic Oscillator) (K3, K4, K5, K6)
- 3.5 Proof of invariance of Poisson's Bracket under canonical transformations (K3, K4)
- 3.6 Infinitesimal contact transformation (K1, K3)

Unit IV: Hamilton-Jacobi Theory (14 Hours)

- 4.1 Hamilton-Jacobi equations (K1, K2)
- 4.2 Hamilton's Characteristic function - Physical Significance (K1, K2)
- 4.3 Linear Harmonic Oscillator problem by Hamilton Jacobi method (K3, K4, K5)
- 4.4 Action Angle variables - Problem of harmonic oscillator using action angle variables (deduction of frequency of motion) (K3, K4, K5)
- 4.5 Hamilton Jacobi method and Motion of a particle in a plane under a central force (K2, K3)
- 4.6 Application to Kepler's problem based on Hamilton Jacobi method (K3, K4, K5)

Unit V: Small oscillations (15 Hours)

- 5.1 Introduction - General theory of small oscillations (K1, K2)
- 5.2 Secular equations and Eigen value equations - solution to Eigen value equations (K1, K2)
- 5.3 one dimensional oscillator - The Lagrangian of one dimensional oscillator and its solution (K3, K4, K5)

- 5.4 Two coupled oscillators - Lagrangian equation of two coupled oscillators and its solution (K3, K4, K5)
- 5.5 Example of two coupled oscillator: Two coupled pendulum (K3, K4, K5, K6)
- 5.6 Vibrations of linear triatomic molecule (K3, K4, K5)

Books for Study:

1. J.C. Upadhyaya - Classical Mechanics - Himalaya Publishing House, Reprint 2003.
2. Gupta Kumar and Sharma - Classical Mechanics, 2nd Edition - PragatiPrakasan, Meerut, 2006.
3. B.D. Gupta and Sathya Prakash - Classical Mechanics - Kedar Nath, Ram Nath, 2003.

Books for Reference:

1. H. Goldstein - Classical Mechanics, 3rd Edition - C. Poole and J. Safko, Pearson Education, Asia, New Delhi, 2002.
2. S.N. Biswas - Classical Mechanics - Books and Allied Ltd., Kolkata, 1998.
3. K. Huang - Statistical Mechanics - Wiley Eastern Ltd., New Delhi, 1975.
4. B.K. Agarwal and M. Eisner - Statistical Mechanics, 2nd Edition - New Age International, New Delhi, 1998.
5. J.K. Bhattacharjee - Statistical Mechanics: An Introductory Text - Allied Publication, New Delhi, 1996.
6. L.D. Landau and E.M. Lifshitz - Mechanics - Pergomon Press, Oxford, 1969.
7. C.R. Mondal - Classical Mechanics - Prentice Hall of India, New Delhi, 2009.
8. L.P. Kadanoff - Statistical Physics: Statics, Dynamics and Renormalization - World Scientific, Singapore, 2001.
9. M. Glazer and J. Wark - Statistical Mechanics - Oxford University Press, 2001.

SEMESTER I

PCPHC20- STATISTICAL MECHANICS

Year: I Sem: I	Course Code: PCPHC20	Title of the Course: Statistical Mechanics	Course Type: Theory	Course Category: Core	H/W 6	Credits 4	Marks 100
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Course Objectives

1. To understand the fundamental principles of thermodynamics and statistical mechanics to perform a quantitative calculations on ideal systems.

Course Outcomes (CO)

The learners will be able to

1. Define and discuss the concepts in thermodynamics and statistical mechanics.
2. Differentiate classical and quantum statistics, explain the statistical behaviour of ideal system (Maxwell, Bose & Fermi) and calculate the statistical quantities.
3. Apply the Bose-Einstein and Fermi-Dirac distributions appropriately to understand the macroscopic properties. (Black body radiation, electrons in metals, paramagnetism etc.)
4. Formulate theories and microscopic models to explain the properties of complex system. (Ising model, Bose-Einstein condensation, liquid helium II)
5. Describe the role of fluctuations and transport phenomena in a system.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	M	L	L	M
CO2	H	M	H	H	H	H
CO3	H	M	H	M	H	L
CO4	M	L	M	M	H	H
CO5	H	M	M	M	M	L

CO	PO					
	1	2	3	4	5	6
CO1	H	H	M	H	M	M
CO2	H	H	H	H	H	M
CO3	H	M	H	H	M	H
CO4	H	M	H	M	H	M
CO5	M	H	M	M	L	L

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Thermodynamics (14 Hours)

- 1.1 Introduction - Thermodynamic potentials (K1, K2)
- 1.2 Phase equilibrium (K1, K2, K3)
- 1.3 Gibb's phase rule - Entropy of mixing and Gibb's paradox (K1, K2, K3)
- 1.4 Phase transition and Ehrenfest's Classification (K2)
- 1.5 Landau theory of Phase transition (K2, K3)
- 1.6 Critical indices- Scale transformation and dimensional analysis (K2, K3)

Unit II: Ensembles (14 Hours)

- 2.1 Introduction - Phase space (K2)
- 2.2 Micro canonical, Canonical and grand canonical ensembles (K2, K3, K4)
- 2.3 Trajectories and density of states (K2, K3)
- 2.4 Liouville's theorem (K2, K3, K4)
- 2.5 Partition function - Calculation of statistical quantities (K3, K4, K5)
- 2.6 Energy and density fluctuations (K3, K4, K5)

Unit III: Maxwell-Boltzmann statistics and Bose-Einstein statistics (15 Hours)

- 3.1 Postulates of classical and quantum statistics (K2, K3)
- 3.2 Density of matrix - Statistics of indistinguishable particles (K2, K3, K4)
- 3.3 Maxwell- Boltzmann distribution function - Broadening of spectral lines (K3, K4)
- 3.4 Bose-Einstein statistics - Bose-Einstein distribution of gas (K2, K3, K4)
- 3.5 Equation of states - black body radiation (K3, K4)
- 3.6 Bose - Einstein condensation - Landau's theory of Liquid Helium II (K3, K4)

Unit IV: Fermi-Dirac statistics (14 Hours)

- 4.1 Fermi-Dirac distribution - Equation of states (K2, K3, K4)
- 4.2 Free electron gas in metals (K2, K3, K4)
- 4.3 Heat capacity (K2, K3, K4)
- 4.4 Pauli's paramagnetism (K2, K3, K4)
- 4.5 Thermionic emission (K2, K3, K4)
- 4.6 Superconductivity (K2, K3, K4)

Unit V: Ising model and Fluctuations (15 Hours)

- 5.1 Ising model - Mean field theories of the Ising model in three, two and one dimension (K2, K3, K4)
- 5.2 Exact solutions in one dimension (K2, K3, K4, K5)
- 5.3 Correlation of space-time dependent fluctuations (K2, K4)
- 5.4 Fluctuations and transport phenomena (K2, K3)
- 5.5 Brownian motion - Langevin theory (K2, K3, K4)
- 5.6 Fluctuation-dissipation theorem - The Fokker- Planck equation (K3, K4)

Books for study:

1. Gupta, Kumar and Sharma - Statistical Mechanics - PragatiPrakasan, 21st Ed., 2006
2. SathyaPrakash and J.P Agarwal - Statistical mechanics - KedarNath Ram Nath, 2005.
3. SathyaPrakash and J.P. Agarwal - Thermodynamics, statistical physics and kinetics
4. B.B.Laud- Fundamentals of Statistical mechanics - New Age International Pvt Ltd., 2012.

Books for reference:

1. Statistical mechanics and properties of matter - E.S.R. Gopal
2. Statistical physics - L.D. Landau and E. M. Lifshitz
3. K. Srivastava and J. Ashok - Statistical mechanics - Prentice-Hall of India Pvt. Ltd., 2005.
4. Brijlal, Dr. N. Subrahmanyam, P.S. Hemne - Heat Thermodynamics and Statistical Physics - S.Chand.
5. Dr. D. Jayaraman, Dr. K. Ilangoan - Thermal Physics and Statistical Mechanics – Viswanathan(Publishers).

SEMESTER I

PEPHA20 - ELECTIVE IA: ELECTRONIC DEVICES AND APPLICATIONS

Year: I Sem: I	Course Code: PEPHA20	Title of the Course: Electronic Devices and applications	Course Type: Theory	Course Category: Major Elective	H/W 5	Credits 4	Marks 100
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Course Objectives

1. To teach the students the methods of the fabrication of digital circuits and the devices used in the design of digital systems.
2. To understand the principles of operational amplifier and its applications and digital communication.

Course Outcomes (CO)

The learners will be able to

1. Analyze about the fabrication of various Integrated circuits and semiconductor devices (construction, working, principles and V-I characteristics) and their applications.
2. Ability to understand about the basic principles and operations of opto electronic devices and their features and applications.
3. To study the Timer IC and its applications.
4. To know the principles, configuration, linear and non-linear applications of Op-amp used to design various digital circuits.
5. To understand the concepts of combinational circuits and sequential circuits and A/D –D/A converters used to design advanced digital system.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	M	H	H	H
CO2	H	H	L	H	M	M
CO3	M	H	M	H	M	M
CO4	M	H	H	H	M	H
CO5	H	M	M	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	M	H	H	H	H
CO5	M	M	M	M	M	H

(Low -L, Medium– M, High-H)

Course Syllabus

Unit I: FinFET and SET

(16 Hours)

- 1.1 Multi gate transistors - Need of FinFET- Structure of FinFET - Fabrication - Mechanism of FinFET Technology-Bulk FinFET- SOI FinFET(K1, K2, K3)
- 1.2 FinFET Classifications: Gate shorted (SG), Insulated Gate (IG) and Low Power (LP) - n-FinFET and p-FinFET - Working of FinFET- I-V characteristics of FinFET(K2, K3, K4)
- 1.3 Applications of FinFET - Design of Switches, logic gates, flip-flops and Schmidt trigger using FinFET(K3, K4, K5)
- 1.4 Single Electron Transistor: Principle - Quantum dots - Coulomb blockade and electron tunneling –Construction and operation of SET (K3, K4)
- 1.5 Single island RC equivalent circuit of SET- Operation Temperature - Different ways to increase Coulomb energy E_c - I-V characteristics of symmetric and asymmetric junction (Coulomb Stair-Case) SET (K3, K4, K5)
- 1.6 Design of logic gates using SET - Realization of AND, OR and NOT gates using SET - Advantages and disadvantages of SET- Difference between SET and FET - Applications of SET (K4, K5, K6)

Unit II: Opto Electronic Devices

(12 Hours)

- 2.1 Light units - Light emitting diodes - Operation and construction - Characteristics and parameters (K1, K2)
- 2.2 Seven-segment displays - LED seven-segment display - liquid crystal cells - LCD seven-segment displays(K1, K2, K3)
- 2.3 Photoconductive cells - Construction - Characteristics and Parameters - Applications(K2, K3, K4)
- 2.4 Photodiodes and Solar cells - Photodiode operation - characteristics - specification - construction- Applications - Solar cells (K2, K4, K5, K6)
- 2.5 Phototransistors (BJT) - Characteristics and specifications - Applications - Photo-Darlingtons- Photo-FET-Optocouplers- Operation and constructions - specification - Applications (K2, K3, K4)
- 2.6 Laser diode - Operation - Characteristics and parameters- Drive circuits - Modulation (K3, K4, K5, K6)

Unit III: 555 Timer and Applications

(13 Hours)

- 3.1 555 Timer - Description (K1, K2)
- 3.2 Monostable operation - Frequency divider(K1, K2, K3)
- 3.3 Astable operation - Schmitt trigger (K2, K3)
- 3.4 Phase Locked Loops - Basic principles (K2, K3, K4, K6)
- 3.5 Analog phase detector(K2, K3)
- 3.6 Voltage Controlled Oscillator - Voltage to Frequency conversion (K2, K3)

Unit IV: Op-Amp Applications

(18 Hours)

- 4.1 Instrumentation amplifier - V to I and I to V converter - Op-amp circuits using diodes - Sample and Hold circuits (K1, K2)
- 4.2 Log and Antilog amplifiers –Multiplier and Divider - Electronic analog Computation (K2, K3, K4)
- 4.3 Phase shift and Wein bridge sine wave oscillators (K1, K2, K3)

- 4.4 Solution to simultaneous equations and differential equations - Schmitt Trigger - Astable, Monostable Multivibrator (K2, K3, K4, K6)
- 4.5 Square, Triangular and Saw tooth wave generators (K2, K3, K4, K6)
- 4.6 RC Active filters - Low pass, High pass and Band pass filter (K2, K3, K4)

Unit V: Digital Electronic Devices

(13 Hours)

- 5.1 4bit Binary adder/subtractor IC 7483 (K1, K2, K3, K4)
- 5.2 Multiplexer IC 74150 and Demultiplexer IC 74154 (K1, K2)
- 5.3 Counters: Binary Counter - BCD Counter - Parallel Counters (K1, K2)
- 5.4 D/A Converters: Binary Weighted Resistor method - R-2R Ladder method (K1, K2, K3)
- 5.5 A/D Converters: Counter type, Successive Approximation (K2, K3, K4)
- 5.6 Dual Slope method - Parallel comparator A/D converter (K2, K3, K4)

Books for Study:

1. D. Roy Choudhury - Linear Integrated Circuits - Wiley Eastern, New Delhi, 1991.
2. V.Vijayendran - Introduction to Integrated Electronics, S.Viswanathan (Printers & Publishers), Pvt. Ltd., 2007.
3. Amar K.Ganguly - Optoelectronic Devices and Circuits - Narosa Publishing House, 2007.
4. R.A. Gaekwad - Op-Amps and Integrated Circuits EEE, 1994.
6. CMOS VLSI Design: A circuit and systems perspective, by Neil H.E. Weste, David Harris and Ayan Banerjee Third edition , Pearson
7. Physics of Semiconductor Devices by J.P. Colinge, C.A. Colinge
8. FinFETs and Other Multi-Gate Transistors by J.-P. Colinge
9. Hybrid CMOS Single-Electron-Transistor Device And Circuit Design by Santanu Mahapatra, Adrian Mihai Ionescu
10. Nanoscale Transistors: Device Physics, Modeling and Simulation Mark Lundstrom, Jing Guo

Book for Reference:

1. R.F. Coughlin and F.F, Driscoll - Op-Amp and Linear Integrated Circuits, Prentice Hall of India, New Delhi, 1996.
2. M.S.Tyagi - Introduction to Semiconductor Devices - Wiley, New York, 2014.
3. Deboo/ Burrous - Integrated circuits and Semiconductor Devices - Theory and Application, McGraw Hill, New Delhi, 1985.
4. Ramakant Gaekwad - Operational Amplifiers - Wiley Eastern, New Delhi, 1981.
5. S.M. Sze - Semiconductor Devices - Physics and Technology, Wiley, New York, 1985.
6. Millman and Halkias - Integrated Electronics - McGraw Hill, New Delhi.
7. Quantum Transport: Atom to Transistor by Supriyo Datta Organic field-effect transistors by Bao Z., Locklin J. (eds.)

SEMESTER I

PIPHA20 –IEP: PHYSICS FOR SET / NET - PAPER-I

Year: I	Course Code:	Title of the Course:	Course Type:	Course Category:	H/W	Credits	Marks
Sem: I	PIPHA20	IEP:Physics for SET/NET-Paper-I	Theory	Independent Elective	-	2	100

Course Objectives

1. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.
2. To analyze logic processes and implement logical operations using combinational and sequential logic circuits.
3. To understand the basic concepts of thermodynamic.
4. To impart knowledge about Classical Mechanics, Electronics and Statistical mechanics for competitive Examinations.

Course Outcomes (CO)

The learners will be able to

1. Describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
2. Design and analyze of electronic circuits
3. Develop a digital logic and apply it to solve real life problems.
4. Ability to identify the properties of substances on property diagrams and obtain the data from property tables.
5. To acquire knowledge about classical and Quantum statistical mechanics.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	M	M	L	M
CO2	H	M	H	H	M	L
CO3	H	L	M	M	H	H
CO4	H	L	M	M	H	M
CO5	H	M	L	H	M	L

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	M	M	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	M	H	M
CO5	H	H	L	H	M	L

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Classical Mechanics

Dynamical systems - Phase space dynamics - Euler's angles and Euler's equation of motion - Lagrangian and Hamiltonian formalism and equations of motion - Conservation laws and cyclic coordinates - Principle of least action - Poisson's Bracket - Canonical transformations - Hamilton Jacobi theory - Linear harmonic oscillator problem - Action angle variables - Small oscillations - Normal modes - Linear triatomic molecule. Classical statistics - Ensembles, Liouville's theorem - Quantum statistics - Maxwell-Boltzmann - Bose-Einstein - Fermi-Dirac.

Unit II: Electronics - I

Semiconductor devices - Diodes - Rectifiers - Filters - Transistors, FET, UJT - Optoelectronic devices - Solar cells, photo detectors - LEDs structure - Characteristics - Frequency dependence and applications. Op-Amp and their applications -

Unit III: Electronics - II

Amplifiers - Oscillators - Logic circuits & logic families - Flip flops - Registers - Counters and Comparator circuits - A/D and D/A converters - Op-Amp based instrumentation amplifier - Feedback - Filtering and noise reduction - Shielding and grounding - 555 timer - IC 565- Lock-in detector - Modulation techniques. Elementary ideas of Microprocessor and Microcontroller - Transducers - Temperature/ Pressure/Vacuum magnetic fields - Vibration - Optical detectors - Solar cells - Photo detectors - LED's - Digital techniques and applications.

Unit IV:

Thermodynamics:

Equation of state for various thermodynamics systems - laws of thermodynamics - thermodynamic potentials - phase equilibrium - Gibbs phase rule - phase transitions and Dia, para and ferromagnetism - Ehrenfest's classification.

Classical Statistical Mechanics:

Phase space, micro and macro states - Micro-canonical - Canonical and Grand canonical ensembles and partition function - Statistical ensemble - Statistical postulates - Probability calculations - Partition function and their properties - Calculation of statistical quantities - Langevin's theory of paramagnetism.

Unit V: Quantum Statistical Mechanics:

Postulates of Quantum statistical mechanics - Density operator and matrix - Properties of ideal Bose & Fermi gases - Bose-Einstein condensation - Cluster expansion for a classical gas - Virial equation of state - Ising model - One dimensional Ising model - Correlation of space - Time dependent fluctuations - Brownian motion - Black body radiation and Plank's radiation law.

Books for study:

1. J.C. Upadhyaya - Classical Mechanics, Himalaya Publishing house, Reprint 2017.
2. J.D. Jackson - Classical Electrodynamics, Willey Eastern Ltd., New Delhi, 1975.
3. R.A. Gaekwad - Op-Amps and Integrated circuits - EEE, 2012.
4. D. Roy Choudary and Shail B. Jain - Integrated Circuits - New Age International Publishers 2011.
5. V. K. Mehta and Rohit Mehta- Principles of Electronics - S. Chand & Co., New Delhi, Reprint 2014.
6. SathyaPrakash - Statistical Mechanics (1994) - Kedar, Meerut, 1994.
7. F. Reif - Fundamentals of Statistical and Thermal Physics - McGraw Hill, Auckland 1965.
8. S.K. Sinha -Introduction to Statistical Mechanics - Alpha Science International,2005

Books for reference:

1. H. Goldstein - Classical mechanics, 3rd Ed., C. Poole and J. Safko, Pearson Education, Asia, New Delhi, 2015.
2. S.M. Sze - Semiconductor Devices: Physics and Technology - Wiley, New York, 1985.
3. SathyaPrakash - Statistical Mechanics, Kedar Publications, Meerut, 2017.
4. R.K. Pathria, Paul D.Beale,-Statistical Mechanics - Butterworth Heinemann, UK, 1996.

SEMESTER I

PIPHB20 –IEP: ASTRO PHYSICS

Year: I Sem: I	Course Code: PIPHB20	Title of the Course: IEP: Astro Physics	Course Type: Theory	Course Category: Independent Elective	H/W -	Credits 2	Marks 100
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Course Objectives

1. To make the students acquire the knowledge about the universe
2. To provide a clear understanding of Astro Physics.
3. To explain the relationship between mass and gravity in solar system.
4. To formulate astrophysical problems in mathematical terms; solve with analytic and numerical methods
5. To propose, plan, and conduct astronomical observations with professional telescopes

Course Outcomes (CO)

The learners will be able to

1. In-depth knowledge within the defined area of astrophysics.
2. Explain stellar evolution, including supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories.
3. Detail the presently accepted formation theories of the solar system based upon observational and physical constraints.
4. Detail the main features and formation theories of the various types of observed galaxies, in particular the Milky Way.
5. Develop observation skills to be able to explain astronomical features and observations obtained via telescopic observations.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	H	M	L	H
CO2	H	M	H	H	H	H
CO3	H	L	H	M	H	L
CO4	H	L	H	M	M	H
CO5	H	M	H	H	M	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	M	H	H	H	H
CO3	H	H	H	M	H	M
CO4	H	M	H	H	M	H
CO5	H	H	H	H	H	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Solar system (14 Hours)

- 1.1 Basic ideas of the Solar system - Geo-centric theory - Helio-centric theory (K1, K2)
- 1.2 Kepler's laws of gravitation - Newton's law of gravitation (K1, K2, K3)
- 1.3 Physical processes in the solar system (K1, K2)
- 1.4 Dynamics of the solar system - physics of planetary atmospheres (K1, K2)
- 1.5 Individual planets; comets, asteroids, and other constituents of the solar system (K1, K2)
- 1.6 Extra-solar planets - formation of the solar system, stars, and planets (K1, K2)

Unit II: The Sun (13 Hours)

- 2.1 The sun - A typical star - Helioseismology (K1, K2)
- 2.2 Temperature distribution near the photosphere - Limb darkening (K1, K2, K3)
- 2.3 Chromospheres - Spicules, plages and filaments - Solar granulation (K1, K2)
- 2.4 Solar corona - Prominences - Solar flares - Radio emission from the sun (K1, K2)
- 2.5 Solar wind - Pyrheliometer (K1, K2, K3)

Unit III: The Stars (16 Hours)

- 3.1 Stars - General Distances to stars - Stellar masses and radii (K1, K2)
- 3.2 Measuring of masses and stellar radii - Colour index of stars (K1, K2)
- 3.3 Stellar Evolution - Birth of a star - Maturity - Ageing of stars (K1, K2)
- 3.4 Death of a star - Types of Stars - Binary, multiple, variable, erupting and exploding stars (K1, K2)
- 3.5 Interstellar medium: Nebulae - Novae - Super Novae - White Dwarfs (K1, K2)
- 3.6 Electrons in white Dwarfs - Neutron stars - Pulsars - Quasars - Black holes (K1, K2)

Unit IV: The Galaxy (15 Hours)

- 4.1 The Galaxy - Hubble's law - Schematic representation of the general structure of galaxy (K1, K2)
- 4.2 The nucleus, the galactic disk and the galactic halo - Dark matter (K1, K2)
- 4.3 Milky way - Hubble classification of galaxies (K1, K2)
- 4.4 Spiral galaxies - Elliptical galaxies - Irregular galaxies (K1, K2)
- 4.5 Dwarf galaxies - Masses of galaxies (K1, K2)
- 4.6 Rotation curves of galaxy - the general rotation law (K1, K2)

Unit V: Cosmic Rays and Instrumentation (14 Hours)

- 5.1 Cosmic rays - Discovery of Cosmic rays - Latitude effect (K1, K2, K4)
- 5.2 Azimuth effect - Altitude effect - longitude effect (K1, K2)
- 5.3 Primary cosmic rays - Secondary rays - Detection methods (K1, K2, K3, K4)
- 5.4 Cosmic ray showers - Vanallen Belts (K1, K2)
- 5.5 Astronomical Instruments: Reflecting and refracting telescopes (K2, K4)
- 5.6 Radio telescopes - Hubble space telescope (HST) (K2, K4)

Books for study:

1. BaidyananthBasu- An Introduction to Astro Physics - Prentice Hall of India, 2004.
2. K.S.Krishnaswamy- Astro Physics: A Modern Perspective - Reprint, New Age International Pvt.Ltd., New Delhi, 2002.
3. G.K.Sasidharan- The Great Universe - S.Chand& amp; Company Ltd., New Delhi - 2008.
4. R.Murugesan&KiruthigaSivaprasath - Modern Physics - S.Chand& amp; Co. Publication - 2007.

Books for Reference:

1. V.B.Bhatia- Textbook of Astronomy and Astro Physics with Elements of Cosmology - Narosa Publishing House, New Delhi, 1998.
2. R.R.Danial- Concepts of Space Science - University Press, Reprint 2002.
3. K.CosmicKapoor- Space Book - Lotus Press, 2005.

SEMESTER II

PCPHD20 - MATHEMATICAL PHYSICS – II

Year: I Sem: II	Course Code: PCPHD20	Title of the Course: Mathematical Physics - II	Course Type: Theory	Course Category: Core	H/W 6	Credits 5	Marks 100
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Course Objectives

1. To inculcate to the students the mathematical concepts for solving physical problems which arise in many branches of Physics.

Course Outcomes (CO)

The learners will be able to

1. Apply concepts of complex analysis to evaluate definite integrals.
2. Explain various operations of tensors and apply in many branches of science.
3. Apply Laplace/Fourier transforms to solve mathematical problems and use Fourier transforms as an aid for analysing experimental data.
4. Use various probability distribution methods to analysis any experimental event.
5. Apply the concept of group theory in the domain of physical sciences.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	M	H	H
CO2	H	L	L	M	H	H
CO3	H	M	H	H	H	H
CO4	H	M	H	M	H	H
CO5	H	M	H	M	H	L

CO	PO					
	1	2	3	4	5	6
CO1	H	M	H	M	M	H
CO2	H	H	M	H	H	H
CO3	H	H	H	M	H	H
CO4	H	H	H	H	H	M
CO5	H	M	M	M	L	L

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Complex Variables

(15 Hours)

- 1.1 Analytic functions - Cauchy-Riemann conditions (K2, K3, K4)
- 1.2 Single and multi-valued functions (K2, K3, K4)
- 1.3 Cauchy's integral theorem and formula (K2, K3, K4, K5)
- 1.4 Taylor's theorem and Laurent's theorem (K2, K3, K4, K5)
- 1.5 Poles and Residues - Cauchy's residue theorem (K2, K3, K4, K5)
- 1.6 Application to evaluation of definite integrals of round unit circle and an infinite semi-circle (K2, K3, K4, K5)

Unit II: Tensors

(13 Hours)

- 2.1 Introduction - Transition of coordinates - Einstein's summation convention (K2, K3, K4)
- 2.2 Contravariant, co-variant and mixed tensors - Rank of a tensor - Tensors of higher ranks (K2, K3, K4)
- 2.3 Kronecker delta symbol - Invariant tensors - Levi civita symbol- Reciprocal tensors - Relative and absolute tensors (K2, K3, K4)
- 2.4 Algebraic operations of tensors - Outer product, Contraction, Inner product and Quotient law (K2, K3, K4)
- 2.5 Symmetric and anti-symmetric tensors (K2, K3, K4)
- 2.6 Basic idea of Christoffel's 3-index symbols - Covariant derivative of a tensor (K2, K3, K4)

Unit III: Integral Transforms

(15 Hours)

- 3.1 Laplace transforms and inverse Laplace transforms (K3, K4, K5)
- 3.2 Solution of linear differential equations with constant co-efficients- evaluation of integrals(K3, K5)
- 3.3 Fourier transforms - Fourier sine and cosine transforms (K3, K4, K5)
- 3.4 Convolution theorem (K4)
- 3.5 Simple applications(K3,K5)

Unit IV: Probability Theory

(15 Hours)

- 4.1 Probability densities and probability distributions(K2, K3, K5)
- 4.2 Binomial, Poisson's and Normal distributions(K2, K3, K5)
- 4.3 Moments and generating functions (K2, K3, K5)
- 4.4 Discrete distributions (K2, K3, K5)
- 4.5 Casual and uniform distribution (K2, K3, K5)
- 4.6 Cauchy continuous distribution (K2, K3, K5)

Unit V: Group Theory

(14 Hours)

- 5.1 Definition of groups, subgroups and conjugate classes - Invariant subgroup (K2, K4)
- 5.2 Homomorphism and isomorphism between groups (K2, K4)

- 5.3 Point groups - Representation of a group - Reducible and irreducible representations (K2, K4)
- 5.4 Schur's lemma - Great orthogonality theorem (K4)
- 5.5 Character table - Construction of character table for C_{3v} and C_{4v} group (K3, K6)
- 5.6 Continuous and Lie groups - Symmetry group of Schrodinger equation - Two dimensional Rotation group $R+(2)$ - Three dimensional Rotation group $R+(3)$ (K4)

Books for Study:

- 1. Sathyaprakash - Mathematical Physics - S.Chand& Sons, Reprint 2006.
- 2. B.D.Gupta- Mathematical Physics, 3rd Edition - Vikas Publishing House Pvt. Ltd., 2004.
- 3. E. Kreyszig - Advanced Engineering Mathematics, 8th Edition - Wiley, New York, 1999.
- 4. H.K. Dass - Mathematical Physics - S.Chand, Reprint 2007.

Books for reference:

- 1. M. Hamermesh - Group Theory and Its Application to Physics: Problems – Addison Wesley, London, 1962.
- 2. C.R. Wylie and LC. Barrett - Advanced Engineering Mathematics, 6th Edition, International Edition, McGraw Hill, New York, 1995.
- 3. P.K. Chakrabarti and S.N. Kundu - A Textbook of Mathematical Physics - New Central Book Agency, Kolkata, 1996.
- 4. A.K. Ghatak, I.C. Goyal and S.H. Chua - Mathematical Physics - Macmillan India, New Delhi, 2002.
- 5. M.D. Greenberg - Advanced Engineering Mathematics, 2nd International Edition - Prentice Hall International, New Jersey, 1998.
- 6. P.K. Chattopadhyay - Mathematical Physics - Wiley Eastern, Madras, 1990.
- 7. F.A. Cotton - Chemical Applications of Group Theory - Wiley Eastern, New Delhi, 1987.
- 8. A.W. Joshi - Elements of Group Theory for Physicists - (Wiley Eastern, New Delhi, 1971).
- 9. G. Arfken and H.J. Weber - Mathematical Methods for Physics, 5th Edition – Harcourt (India), New Delhi, 2001.

SEMESTER II

PCPHE20 - ELECTROMAGNETIC THEORY

Year: I Sem: II	Course Code: PCPHE20	Title of the Course: Electromagnetic Theory	Course Type: Theory	Course Category: Core	H/W 5	Credits 5	Marks 100
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Course Objectives

1. To make the students understand the principles and theory of electrostatics, magneto statics.
2. To familiarize the students with electromagnetic waves and its applications.

Course Outcomes (CO)

The learners will be able to

1. Able to understand and apply the basic principles of electrostatics
2. Analyses the properties of magnetostatic field through current distribution with the application of various laws and conditions.
3. Able to perceive the propagation and interaction of electric and magnetic fields through free space and matter
4. Imbibes the wide-spread knowledge about radio communication with its mathematical applications.
5. Acquires the comprehensive knowledge of the various applications of antennas

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	M	M	M	L
CO2	H	H	H	H	H	L
CO3	H	H	M	M	H	L
CO4	H	H	H	H	L	M
CO5	H	H	M	M	H	L

CO	PO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	H
CO2	M	M	H	M	M	M
CO3	M	M	M	H	H	H
CO4	H	M	H	M	H	H
CO5	M	H	H	M	M	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Electrostatics

(14 hours)

- 1.1 Electrostatic potential - Poisson's equation and Laplace's equation from Gauss' law (K1, K2)
- 1.2 Solution of Laplace's equation in spherical co-ordinates - Solution to Laplace equation in cylindrical coordinates - solution to Laplace equations in Cartesian coordinates (K2, K3, K5)
- 1.3 Polar molecules - Langevin equation (K2, K3, K5)
- 1.4 Non-polar molecules - Clausius-Mossotti relation (K2, K3, K4)
- 1.5 Polarization vector - Electric field at external and internal points due to polarization - Displacement vector (K1, K2, K3)
- 1.6 Conducting sphere in a uniform field - Dielectric sphere in a uniform field (K3, K4, K5)

Unit II: Magnetostatics

(15 hours)

- 2.1 Magnetic field of steady current - current density J (K1, K2)
- 2.2 Ampere's circuital law - Force on current carrying conductors and charges - Force between parallel wires & force on a point charge moving in a magnetic field (Lorentz force) (K2, K3)
- 2.3 Magnetic scalar potential - Application to a circular coil (K2, K3, K4)
- 2.4 Magnetic vector potential - Application to a long current carrying wire - Line integral of a vector potential over a closed curve (K2, K3, K4)
- 2.5 Lorentz condition - Magnetic shielding (K3, K5)
- 2.6 Energy in a magnetic field (K3, K4)

Unit III: Maxwell's Equations

(15 hours)

- 3.1 Faraday's laws of electro-magnetic induction - Faraday's law in vector form (K1, K2, K4)
- 3.2 Maxwell's displacement current - Maxwell's equations - Derivation (K2, K3, K4)
- 3.3 Electromagnetic Potentials \mathbf{A} and ϕ (Vector and Scalar potentials) - Maxwell's equations in terms of Electromagnetic Potentials (K2, K4)
- 3.4 Non-uniqueness of Electromagnetic Potentials - Gauge invariance - Lorentz gauge and Coulomb gauge (K3, K4, K5)
- 3.5 Conservation laws for a systems of charges and electromagnetic fields - Equation of Continuity (charge) - Momentum in EM Fields - Energy in EM fields (Poynting theorem) (K3, K4, K5)
- 3.6 Wave equation in general - Plane wave solution for free space (K2, K3)

Unit IV: Application of Maxwell's Equations

(14 hours)

- 4.1 Fields and radiation of localized sources (K1, K2)
- 4.2 Oscillating electric dipole - Radiation from an oscillating electric dipole - Poynting vector and radiated power (K2, K3, K4)

- 4.3 Radiation from a small current element - Electric field and Radiation resistance (K3, K4)
- 4.4 Radiation from a linear antenna –Electric field intensity, Magnetic field intensity, radiated power (K4,K5)
- 4.5 Antenna arrays - Broad side array - end fire array (K4,K5)
- 4.6 Radiation pressure - Electromagnetic oscillators (K4,K5)

Unit V: Wave Propagation

(14 hours)

- 5.1 Propagation of electromagnetic waves in isotropic and anisotropic dielectrics (K3, K4)
- 5.2 Propagation in conducting media - Calculation of Phase Velocity - Refractive Index - Skin depth (K3,K4)
- 5.3 Linear and circular polarization - Reflection and refraction at a plane interface (K2,K3)
- 5.4 Propagation of waves in a rectangular wave guide - TE Waves - TM Waves (K4,K5)
- 5.5 Cavity resonator - TE Mode - TM Mode (K4,K5)
- 5.6 Faraday and Kerr effects (K4)

Books for Study:

1. Chopra, Agarwal - Electromagnetic Theory, 5th Edition - K. Nath & Co, Meerut, 2014.
2. SathyaPraksah - Electromagnetic Theory and Electrodynamics - Kedarnath Ramnath &Co., 2006.
3. Gupta, Kumar, Singh - Electrodynamics - PragatiPrakashan, Meerut, 2003.

Books for Reference:

1. J.D. Jackson - Classical Electrodynamics - Willey Eastern Ltd., New Delhi, 1975.
2. D.J.Griffiths - Introduction to Electrodynamics, 3rd Edition - Prentice Hall of India, New Delhi, 2002.
3. J.R.Rertz, F.J. Milford and R.W. Christy - Foundations of Electromagnetic Theory, 3rd Edition - Narosha Publication, New Delhi, 1986.
4. W. Panofsky and M. Phillips - Classical Electricity and Magnetism - Addison Wesley, London, 1962.
5. J.D. Kraus and D.A. Fleisch - Electromagnetic with Applications, 2nd Edition - WCB McGraw Hill, New York, 1999.
6. B. Chakraborty - Principles of Electrodynamics -Books and All Kolkata, 2002.

SEMESTER I & II

PCPHG20 - PRACTICAL - I: GENERAL EXPERIMENTS

Year: I	Course Code:	Title of the Course:	Course Type:	Course Category:	H/W	Credits	Marks
Sem: I & II	PCPHG20	Practical I: General Experiments	Practical	Core	3	4	100

Course Objectives

1. To understand the concepts and principles behind in experimental physics.
2. To teach the students to measure the electrical, mechanical, thermal and magnetic properties of materials.
3. Students are trained to handle advanced sophisticated equipments and analyze the data.

Course Outcomes (CO)

The learners will be able to

1. Measure electrical, magnetic and thermo-dynamical properties of solids.
2. Measure the thickness of glass plate (mechanical property) by using cornu's method
3. To find the wavelength of different colors through solar, mercury and hydrogen spectrum.
4. Calculate the acceptance angle and light gathering capability and attenuation properties of optical fiber and find out the Viscosity, specific rotary power and polarizability of different liquids through various experiments.
5. Develop the skills to take an accurate reading and analyze the results of experiments and to solve problems while handling with analytical instruments.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	L	H	H	H
CO2	H	H	L	M	L	H
CO3	H	H	M	M	M	H
CO4	H	H	M	H	M	H
CO5	H	H	L	M	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	M	H	H	M	H
CO2	M	H	H	M	M	M
CO3	M	H	M	H	H	H
CO4	H	M	H	M	H	M
CO5	M	H	H	M	M	H

(Low - L, Medium – M, High - H)

Course Syllabus

(Any 15 experiments)

1. Cornu's method - Determination of Young's modulus of the material beam by elliptical fringes.
2. Cornu's method - Determination of Young's modulus of the material beam by hyperbolic fringes.
3. Determination of Stefan's constant.
4. Band gap energy - using point contact diode (Ge and Si)
5. Hartmann's formula - Determination of wavelength of spectral lines in mercury spectrum.
6. Determination of Rydberg's constant - Hydrogen and Neon spectrum.
7. Solar spectrum - Hartmann's interpolation formula.
8. Co-efficient of linear expansion - Air wedge method.
9. Viscosity of liquid - Meyer's disc.
10. F.P.Etalon- using Spectrometer.
11. Specific charge of an electron –Magnetron method.
12. Energy bandgap of a Semiconductor - Four Probe method (as a function of temperature).
13. Edser and Butler fringes - Thickness of air film.
14. Spectrometer - Charge of an electron.
15. Spectrometer - Polarisability of liquids by finding the refractive indices at different wavelengths.
16. Permittivity of a liquid using RFO.
17. B-H loop using Anchor ring.
18. Determination of strain hardening co-efficient.
19. Determination of Audio frequencies - Bridge method.
20. Specific heat of a liquid - Ferguson's method.
21. Measurement of Numerical aperture (NA) of a telecommunication graded index optic fiber (for different length of fibers).
22. Fiber attenuation of the given optical fiber (between different lengths of fibers).
23. Biprism - Wavelength of monochromatic source - using Spectrometer.
24. Determination of specific rotatory power of a liquid using polarimeter.
25. Compressibility of a liquid using ultrasonic interferometer.
26. Lasers: study of laser beam parameters.

SEMESTER I & II

PCPHH20 - ELECTRONICS LAB

Year: I	Course Code:	Title of the Course:	Course Type:	Course Category:	H/W	Credits	Marks
Sem: I & II	PCPHH20	Electronics Lab	Lab	Core	3	4	100

Course Objectives

1. Students will learn and understand the Basics of digital electronics.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand concepts of sequential circuits and to analyze sequential systems.
4. To analyze the different RC and LC oscillator circuits to determine the frequency of oscillation

Course Outcomes (CO)

The learners will be able to

1. Identify the various digital ICs and understand their operation.
2. Develop a digital logic and apply it to solve real life problems.
3. Analyze, design and implement combinational logic circuits.
4. Analyze, design and implement sequential logic circuits.
5. Design the different oscillator circuits for various frequencies.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	M	H	M	M
CO2	H	M	M	H	H	H
CO3	H	L	H	M	L	M
CO4	H	L	H	M	M	H
CO5	H	L	H	M	L	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	M	H	H	H	H
CO5	M	M	M	M	M	H

(Low - L, Medium – M, High - H)

Course Syllabus

(Any 18 experiments)

List of experiments (K1 - K6):

1. V-I Characteristics of SCR and TRIAC.
2. Study of Rectifiers using C, L-C and Pi filters.
3. Study of Voltage - Current characteristics of UJT & UJT as a Relaxation Oscillator.
4. FET as amplifier - frequency response, input impedance and output impedance.
5. Study of V-I Characteristics of J-FET as a VVR (Voltage Variable Resistor).
6. Study of V-I Characteristics of MOSFET.
7. Op-amp - Voltage follower (Inverting) summing, difference, average amplifier- differentiator and integrator.
8. Op-amp - Solving simultaneous equations.
9. Op-amp - Design of square wave generator, triangular wave generator and saw tooth wave generator.
10. Op-amp - 4 bit D/A converter - Binary Weighted Resistor method and R-2R ladder method
11. Op-amp - Design of active Low pass, High pass, Band Pass and band rejector filter.
12. Op-amp - Study of attenuation characteristics and design of Phase Shift Oscillator.
13. Op-amp –Study of attenuation characteristics and design of Wien Bridge Oscillator.
14. IC 555 - Construction of Monostable Multivibrator, Frequency Divider
15. IC 555 -Design of Schmitt Trigger and hysteresis.
16. IC 555 - Construction of Astablemultivibrator and Voltage controlled Oscillator
17. Design of Synchronous and Asynchronous Counters using IC-7476/ 7473.
18. Construction of 4 bit Shift Register - Ring Counter and Johnson Counter - IC7476
19. Study of
 - i) Multiplexer and using IC 74150
 - ii) De-Multiplexer using IC 74154
20. Arithmetic operations (Adder/Subtractor) Using IC 7483.
21. Modulus counter using IC7490 and display using IC7447.
22. Phase locked loops using IC 555.
23. Binary adder abdSubtractor using EX-OR and NAND gates.

SEMESTER II

PEPHC20 - ELECTIVE II A: CRYSTAL GROWTH, NANO SCIENCE AND RESEARCH

METHODOLOGY

Year: I Sem: II	Course Code: PEPHC20	Title of the Course: Crystal Growth, Nano Science and Research Methodology	Course Type: Theory	Course Category: Major Elective	H/W 4	Credits 4	Marks 100
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Course Objectives

1. To provide the students, knowledge on crystal growth techniques and nanoscience
2. To learn the basic concepts in research methodology for pursuing future research work.

Course Outcomes (CO)

The learners will be able to

1. Explain the fundamental concepts behind in the formation of crystal.
2. Demonstrate the various methods in crystal growth techniques and their advantages.
3. Understand the advanced methods of characterization instruments for crystal and nanomaterials.
4. To familiarize about the physical concepts and principles of nanoscience and nanotechnology.
5. Provide a broad view of various approaches for the synthesis and fabrication of nanostructures and their outstanding properties useful to carry out their project and research work.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	M
CO2	H	H	L	H	H	M
CO3	H	H	M	H	H	M
CO4	H	M	M	H	L	H
CO5	H	M	M	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	M	H	H	H	H
CO5	M	M	M	M	M	H

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Nucleation and Growth

(10 Hours)

- 1.1 Nucleation - Different kinds of nucleation - Theories of nucleation (K1, K2)
- 1.2 Classical theory of nucleation - Gibbs Thomson equation for vapour (K1, K2)
- 1.3 Modified Thomson's equation for melt - Gibbs Thomson equation for solution (K1, K2)
- 1.4 Concept of formation of critical nucleus - Spherical and cylindrical nucleus (K1, K2, K3)
- 1.5 Crystal growth techniques - Solution Growth Technique: Low temperature solution growth: Solution - Solubility and super solubility - Expression of super saturation - Miers T-C diagram (K1, K2, K3)
- 1.6 Gel Growth Technique: Principle - Various types - Structure of gel - Importance of gel - Experimental procedure (K1, K2, K3)

Unit II: Growth and Characterization Techniques

(10 Hours)

- 2.1 Melt technique: Bridgman technique - Basic process - Vertical Bridgman technique - Crystal Pulling technique (K1, K2, K3, K4)
- 2.2 Czochralski technique - Experimental arrangement - Growth process (K4, K5, K6)
- 2.3 X - Ray Diffraction (XRD) - Powder and single crystal (K1, K2)
- 2.4 Fourier transforms Infrared analysis (FT-IR) - FT - Raman Elemental analysis (K1, K2)
- 2.5 Elemental dispersive X-ray analysis (EDAX) - Scanning Electron Microscopy (SEM) - Transmission electron microscopy (TEM) (K2, K4, K5, K6)
- 2.6 UV-Vis-NIR Spectrometer - Etching (Chemical) - Vickers Micro hardness - TGA - DTA - PL studies (K4, K5, K6)

Unit III: Basics of Nano Technology

(9 Hours)

- 3.1 History of Nano technology - concept of Nano technology and Nano machines (K1, K2)
- 3.2 Atomic structure molecules and phases - Molecular and atomic sizes - Surfaces and dimensional space (K1, K2, K3)
- 3.3 Top down and bottom up approach in synthesis - Nano scale formation (K3, K4, K5)
- 3.4 Strong intermolecular forces - Covalent and coulomb interactions (K2, K4)
- 3.5 Weak inter molecular forces - Vander Waal forces - Repulsive forces (K2, K4, K5)
- 3.6 Hydrogen bonding, Hydrophobic and hydrophilic interactions (K2, K5, K6)

Unit IV: Fabrication Techniques and Properties of Nano-Structure

(9 Hours)

- 4.1 Vacuum Techniques: Thermal evaporation - Physical Vapour deposition - Ionized Cluster beam deposition - Laser vaporization (ablation) - laser pyrolysis (K1, K2, K3)
- 4.2 Sputter deposition - DC sputtering - RF sputtering - Magnetron sputtering - ECR plasma deposition (K1, K2)
- 4.3 Chemical vapour deposition - Electric arc deposition - Ion beam techniques - molecular beam epitaxy (K2, K3, K4)
- 4.4 Nanolithography techniques: Lithography using Photons (UV-VIS, Lasers and X-rays) (K2, K3, K5)
- 4.5 Lithography using particle beams - Electron and Ion beam Lithography (K1, K2, K3, K4)
- 4.6 Quantum dots and Quantum wires - Size dependent variation in magnetic properties - Thermal and electronic transport properties (K3, K4, K5, K6)

Unit V: Research Methodology

(10 Hours)

- 5.1 Meaning of research - Objectives of research - Motivation of research - Types, approaches and significance - Methods versus methodology (K1, K2, K3)
- 5.2 Identification of the problem - Literature survey - Reference collection - Necessity and techniques involved in defining the problem (K2, K3, K4)
- 5.3 Research design - Needs and features of good design - Different research design - Basic principles of experimental designs - Meaning of research report (K2, K3, K4)
- 5.4 Logical format for writing thesis and paper - Essential of scientific report: abstract, introduction, review of literature, materials and methods and discussion (K3, K4, K5)
- 5.5 The use of quotation, footnotes, tables and figures - Referencing - Appendixes - Revising the paper or thesis (K4, K5, K6)
- 5.6 Oral power point presentation - Poster preparation - Editing and evaluating the final product - Proof reading - The final typescopy (K4, K5, K6)

Books for Study:

1. Charles P. Poole, Frank J. Owens - Introduction to Nanotechnology - Wiley- Interscience, 2003.
2. P. Santhana Ragavan and P. Ramasamy - Crystal Growth Processes and Methods - KRU Publications, Kumbakonam, 2001.
3. C.R. Kothari and Gaurav Garg - Research Methodology, Methods and Techniques - New age International Publishers, III Edition, 2014
4. Santosh Gupta - Research Methodology Methods and Statistical Techniques
5. Rajammal et al., -A hand Book of Methodology of Research - Sri Ramakrishna Mission Vidyalaya Press, Coimbatore.

Books for Reference:

1. J.C. Brice - Crystal Growth Processes - John Wiley and Sons, New York, 1986.
2. C. Hawkins & M. Sorigi - Research Ed Norosa Publishing House, New Delhi - 2000
3. Robert Ross - Research: An introduction - - Harper and Row Publications.
4. P. Saravanavel - Research methodology - - Kitlab Mahal, Sixth Edition.
5. R.A. Day - How to write and publish a scientific paper - Cambridge University press
6. Anderson - Thesis and Assignment writing - - Wiley Eastern Ltd.

SEMESTER II

PIPHC20 - IEP: PHYSICS FOR SET/NET - PAPER – II

Year: I Sem: II	Course Code: PIPHC20	Title of the Course: IEP: Physics for SET/NET - paper –II	Course Type: Theory	Course Category: Independent Elective	H/W -	Credits 2	Marks 100
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Course Objectives

1. To recall and apply the knowledge about Mathematical Physics and Electromagnetic Theory for competitive Examinations.

Course Outcomes (CO)

The learners will be able to

1. Recall and apply the concepts and methods in mathematical physics and solve relevant problems in any competitive exams.
2. Understand the characteristics of special functions to solve the physical problems.
3. Apply concepts of complex analysis to evaluate definite integrals, tensors, probability distribution methods and group theory in the domain of physical sciences.
4. Recall and apply the concepts and methods in Electromagnetic theory and solve problems quantitatively in any competitive exams.
5. Acquires comprehensive knowledge of the various applications of wave guides, Maxwell's equations.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	H	M	H	M
CO2	H	L	H	M	H	H
CO3	M	H	M	H	H	M
CO4	H	M	H	M	H	M
CO5	M	H	M	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	M	M	H	H	M
CO4	H	H	H	M	M	H
CO5	H	H	H	H	H	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Mathematical Physics-I

- 1.1 Vector field- Gradient - Divergence - Curl and Laplacian in orthogonal curvilinear (K1, K2, K3, K5)
- 1.2 Spherical and cylindrical coordinate systems (K1, K2, K3)
- 1.3 Gauss-divergence and Stoke's theorem (K1, K2, K3, K5)
- 1.4 Matrices - Types of Matrices - Diagonal matrix (K1, K2)
- 1.5 Cayley-Hamilton theorem (K1, K2, K3)
- 1.6 Eigen values and Eigen vectors(K3, K5)

Unit II: Mathematical Physics-II Special Functions

- 2.1 Bessel, Legendre, Laguerre and Hermite polynomials (K1,K2,K3,K5)
- 2.2 Recurrence relations (K1,K3,K5)
- 2.3 Orthogonality formulae - Rodrigue's formula (K3,K5)
- 2.4 Green's function (K1, K2,K5)
- 2.5 Partial differential equations (K1,K2)
- 2.6 Laplace, wave and heat equations in two and three dimensions (K3,K5)

Unit III: Mathematical Physics-III

- 3.1 Elements of complex analysis - Analytic functions- Poles - Residues and evaluation of integrals (K3, K5)
- 3.2 Taylor and Laurent's series (K1, K3, K5)
- 3.3 Elementary ideas of Tensors (K1, K2)
- 3.4 Laplace and Fourier Transforms - Fourier series (K3, K5)
- 3.5 Elementary probability theory - Binomial - Poisson and Normal distributions (K3, K5)
- 3.6 Introductory group theory - groups and subgroups - Abelian and cyclic groups - Point groups (C_{2v} & C_{3v}) - reducible and irreducible representations and its theorems (K1, K2)

Unit IV: Electromagnetic Theory- I

- 4.1 Electro statics - Gauss law and its applications (K1, K3, K5)
- 4.2 Poisson's and Laplace equations - Boundary value problems (K1, K3, K5)
- 4.3 Magnetostatics- Biot-Savart law (K1, K3, K5)
- 4.4 Ampere's theorem - Lorentz force (K1, K3, K5)
- 4.5 Maxwell's equations in free space and linear isotropic media (K1, K3, K5)
- 4.6 Boundary conditions on the fields- Gauge invariance (K1, K3, K5)

Unit V: Electromagnetic Theory – II

- 5.1 Wave Propagation - Electromagnetic waves in free space (K1, K3, K5)
- 5.2 Dielectrics and conductors - Rectangular wave guides - Cavity resonator (K1, K2)
- 5.3 Dispersion relations in plasma (K3, K5)
- 5.4 Lorentz invariance of Maxwell's equations - Transmission lines and waveguides (K3, K5)
- 5.5 Scalar and vector potentials - Oscillating electric dipole - Pointing vector and radiated power (K3, K5)
- 5.6 Radiation from moving charges and dipoles and retarded potentials (K3, K5)

Books for study:

1. Sathyaprakash - Mathematical Physics, S. Chand & Sons, Reprint 2018.
2. H.K. Dass - Mathematical Physics, S.Chand, Reprint 2017.
3. Chopra Agarwal - Electromagnetic theory - K. Nath& Co. 2008
4. Sathyaprakash-Electromagnetic theory and Electrodynamics, K. Nath& Co.2019.

Books for reference:

1. E. Kreyszig- Advanced Engineering Mathematics, 8th Ed., Wiley, New York, 1999.
2. D.J.Griffiths - Introduction to Electrodynamics, 3rdEd.Prentice Hall of India, New Delhi, 2012.

SEMESTER II

PIPHD20 - IEP: MEDICAL PHYSICS AND INSTRUMENTATION TECHNIQUES

Year: I Sem: II	Course Code: PIPHD20	Title of the Course: IEP: Medical Physics And Instrumentation Techniques	Course Type: Theory	Course Category: Independent Elective	H/W -	Credits 2	Marks 100
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Course Objectives

1. To give a perspective about the concepts of physics involved in human body.

Course Outcomes (CO)

The learners will be able to

1. Explain the effect of pressure on human system.
2. Explain the physics of lungs and respiratory system.
3. Explain the physics of cardiovascular system.
4. Explain the application of electricity and magnetism in medicine.
5. Explain medical imaging techniques.

CO	PSO					
	1	2	3	4	5	6
CO1	M	H	L	H	M	H
CO2	M	H	L	H	M	M
CO3	M	H	L	H	M	H
CO4	H	H	L	H	H	H
CO5	M	H	L	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	M	H	H	H	H
CO5	M	M	M	M	M	H

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Effects of Pressure on Human System

- 1.1 Measurement of pressure in the human body (K2, K3)
- 1.2 Pressure inside the skull (K2, K3)
- 1.3 Transillumination - eye pressure - tonometers- ophthalmoscopy (K2, K3)
- 1.4 Pressure in the digestive system - urinary bladder (K2, K3)
- 1.5 Pressure in the skeletal system - stress and strain - strain gage (K2, K3)
- 1.6 Transducers for biomedical applications (K2, K3)

Unit II: Physics of Lungs and Breathing

- 2.1 The airways - interaction of the blood and the lungs (K2, K3)
- 2.2 Measurement of pulmonary volume - volume relationships of the lungs (K2, K3)
- 2.3 Physics of alveoli - breathing mechanism (K2, K3, K4)
- 2.4 Pulmonary flow - pulmonary diffusion - airway resistance - measurement of airway resistance (K2, K3)
- 2.5 Work done in breathing - measurement of gaseous exchange and diffusion (K2, K3, K4)
- 2.6 Respiratory therapy equipment - physics of some common lung disease (K2, K3)

Unit III: Physics of Cardiovascular Systems

- 3.1 The heart and cardiovascular system (K2, K3)
- 3.2 Oxygen and CO₂ exchange - work done by heart (K2, K3)
- 3.3 Pressure across the blood vessel - characteristics of blood flow - heart sounds (K2, K3)
- 3.4 Blood pressure measurement - indirect measurements - direct measurements (K2, K3, K4)
- 3.5 Percutaneous insertion - catheterization implantation of transducer - measurement of blood flow and cardiac output (K2, K3, K4)
- 3.6 Elements of intensive care monitoring - pacemakers - defibrillators (K2, K3)

Unit IV: Application of Electricity and Magnetism in Medicine

- 4.1 The nervous system and neurons (K2, K3)
- 4.2 Source of bioelectric potentials - testing and action potentials(K2, K3)
- 4.3 Propagation of action potentials - electrodes - theory (K2, K3)
- 4.4 Biopotential electrodes electromyogram-electrocardiogram -electroencephalogram (K2, K3)
- 4.5 Magneto cardiogram - thermography and skin temperature measurements (K2, K3, K4)
- 4.6 Applications of high and frequency electricity in medicine (K2, K3)

Unit V: Medical Imaging Techniques

- 5.1 X-rays and radio isotopes - instrumentation - X-rays in diagnosis (K2, K3, K4)
- 5.2 Medical application of radioisotopes - radiation therapy (K2, K3)
- 5.3 Principles of ultrasonic measurement - ultrasonic diagnosis (K2, K3, K4)
- 5.4 Magnetic Resonance Imaging (MRI) - Computerized Axial Tomography scanner (CAT)(K2, K3, K4)
- 5.5 Positron Emission Tomography (PET) imaging (K2, K3, K4)
- 5.6 Physiological effects of electric current - shock hazards - methods of accident prevention(K2, K3, K4)

Books for study:

1. J.R. Cameron and James G. Skofronick - Medical Physics - John Wiley & Sons Inc. 1978.
2. A.C. Damask - Medical Physics Vol I & II - Academic press 1978, 1981.
3. John G. Webster - Bioinstrumentation - John Wiley & Sons, Inc. 2003.
4. M. Arumugam - Biomedical Instrumentation - Anuradha publications, 2007.

Books for reference:

1. W. Hoppe et al. - Biophysics - Springer - Verlag 1983.
2. A.J. Vander, J.H. Sherman and D.S. Lucian - Human Physiology, McGraw –Hill (International Ed.), 1986.
3. Leslie Cromwell, Fred. J. Weibell Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India Pvt., Ltd., 2007.

SEMESTER III

PCPHI20- SPECTROSCOPY

Year: II	Course Code:	Title of the Course:	Course Type:	Course Category:	H/W	Credits	Marks
Sem: III	PCPHI20	Spectroscopy	Theory	Core	6	4	100

Course Objectives

1. To impart the knowledge about molecular spectroscopic techniques (rotational, vibrational and magnetic resonance spectroscopy).

Course Outcomes (CO)

The learners will be able to

1. Describe theoretical background (classic and quantum) of spectroscopic techniques such as microwave, IR and Raman, NMR, NQR, ESR and Mossbauer spectroscopy.
2. Apply solutions of the Schrodinger equations for simple systems (rigid rotor and harmonic oscillator) to real systems (rotational and vibrational) for use in determining the molecular energy levels.
3. Analyse rotational and vibrational (microwave, IR& Raman) spectra to determine the molecular structure and physical constants.
4. Interpret NMR, NQR, ESR and Mossbauer spectra to obtain the information about the chemical, structural and magnetic properties of the material.
5. Outline the methods, instrumentation and applications (any one application) for the following spectroscopic techniques: microwave, IR, Raman, NMR, NQR, ESR and Mossbauer spectroscopy.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	H	L	M	H
CO2	H	L	H	L	H	M
CO3	H	M	M	M	H	H
CO4	H	M	M	M	H	H
CO5	M	H	L	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	M	H	H	H	M
CO2	H	H	H	M	M	L
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	M	L	M	M	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Microwave Spectroscopy (14 Hours)

- 1.1 Introduction - Pure rotational spectra of diatomic molecule (K2, K3, K5)
- 1.2 Study of linear molecules and symmetric top molecules(K2, K3)
- 1.3 Hyperfine structure and quadruple moment of linear molecules(K2, K4)
- 1.4 Polyatomic molecules(K2)
- 1.5 Experimental techniques(K2, K3, K4)
- 1.6 Molecular structure determination–Stark effect–Applications to chemical analysis(K4, K5)

Unit II: Infrared Spectroscopy (15 Hours)

- 2.1 Vibrational spectroscopy of diatomic molecules - Harmonic Oscillator - Anharmonic Oscillator(K2, K3, K4, K5)
- 2.2 Rotational vibrators (K2, K3, K4)
- 2.3 Vibrational spectroscopy of simple polyatomic molecules -Normal modes of vibration of polyatomic molecules(K2, K3, K4)
- 2.4 Inversion spectrum of ammonia (K2, K4)
- 2.5 Experimental techniques - Infrared spectro- photometer - Reflectance spectroscopy (K2, K3, K4)
- 2.6 Applications of infrared spectroscopy (K3, K4)

Unit III: Raman Spectroscopy (13 Hours)

- 3.1 Classical and quantum theory of Raman Scattering (K2, K3, K4)
- 3.2 Raman effect and molecular structure - Raman effect and crystal structure (K2, K3, K4)
- 3.3 Raman effect in relation to inorganic, organic and physical chemistry (K3, K4)
- 3.4 Experimental techniques (K2, K3)
- 3.5 Coherent Anti stokes Raman Spectroscopy (K2, K3, K4)
- 3.6 Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO₂ molecules (K3, K4)

Unit IV: NMR and NQR Techniques (15 Hours)

- 3.1 Theory of NMR - Bloch equations - Steady state solution of Bloch equations (K3, K4, K5)
- 3.2 Theory of chemical shifts (K2, K3, K4)
- 3.3 Experimental methods - Single coil and double coil methods - Pulse Method - High resolution method(K2, K3)
- 3.4 Applications of NMR to quantitative measurements (K3, K4, K5)
- 3.5 Quadruple Hamiltonian of NQR - Nuclear quadruple energy levels for axial and non-axial symmetry (K2, K3)
- 3.6 Experimental techniques and applications(K3, K4)

Unit V: ESR and Mossbauer Spectroscopy (15 Hours)

- 5.1 Quantum mechanical treatment of ESR - Nuclear interaction and hyperfine structure - Relaxation effects (K2, K3, K4)
- 5.2 Basic principles of spectrograph - Applications of ESR method (K2, K3)

- 5.3 Mossbauer Effect - Recoilless emission and absorption - Mossbauer spectrum (K2, K3, K4)
- 5.4 Experimental methods - Mossbauer spectrometer(K2, K3)
- 5.5 Hyperfine interactions - Chemical Isomer shift - Magnetic hyperfine interactions - Electric quadruple interactions (K2,K3, K4, K5)
- 5.6 Simple biological applications (K3, K4, K5)

Books for Study:

1. Gupta Kumar Sharma - Elements of Spectroscopy –PragatiPrakashan, Meerut 2006.
2. G. Aruldas - Molecular Structure and Spectroscopy - Prentice Hall of India Pvt. Ltd., New Delhi, 2001.
3. B.K. Sharma - Spectroscopy - GOEL Publishing House, Meerut, 2005.
4. C.N. Banwell and E.M. Mc Cash - Fundamentals of Molecular Spectroscopy, 4th Edition - Tata McGraw Hill Publications, New Delhi, 1994.

Books for Reference:

1. D.N. Satyanarayana - Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi, 2004.
2. Atta Ur Rahman - Nuclear Magnetic Resonance –SpingerVerlag, New York, 1986.
3. Towne and Schawlow - Microwave Spectroscopy - McGraw-Hill, 1995.
4. Raymond Chang - Basic Principles of Spectroscopy -McGraw Hill, Kogakusha, Tokyo, 1980.
5. D.A. Lang - Raman Spectroscopy - McGraw Hill International, N.Y., 1977.
6. D.D. Jyaji and M.D. Yadav- Spectroscopy - Amol Publications, 1991.

SEMESTER III

PCPHK20 – MICROPROCESSOR AND MICRO-CONTROLLER

Year: II Sem: III	Course Code: PCPHK20	Title of the Course: Microprocessor and Microcontroller	Course Type: Theory	Course Category: Core	H/W 5	Credits 4	Marks 100
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Course Objectives

1. To make the students understand the concepts that are involved in the Microprocessor 8085 and Microcontroller 8051.
2. To make the students understand instruction sets, addressing modes, timings, memory and I/O interfaces.

Course Outcomes (CO)

The learners will be able to

1. Describe Hardware, different bus cycles and memory interface to 8085 Microprocessor.
2. Develop programs using 8085 Microprocessor Instruction set and addressing modes.
3. Describe and perform different types of peripheral interfaces to 8085 Microprocessor.
4. Explain hardware, instruction set and addressing modes of Microcontroller 8051 and develop programming for basic operations.
5. Describe and perform different types of external interfaces to 8051 Microcontroller.

CO	PSO					
	1	2	3	4	5	6
CO1	H	L	L	M	M	M
CO2	H	H	L	M	M	M
CO3	H	M	L	M	M	M
CO4	H	M	L	M	M	M
CO5	H	M	L	M	M	M

CO	PO					
	1	2	3	4	5	6
CO1	H	M	L	M	M	M
CO2	H	H	H	M	M	M
CO3	H	H	L	M	M	M
CO4	H	H	H	M	M	M
CO5	H	M	L	M	M	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: 8085 Microprocessor- Architecture, Instruction set and Programming (12 Hours)

- 1.1 Architecture- Functional pin diagram (K2)
- 1.2 Buses - Address bus, data bus, multiplexing address/data bus (K2)
- 1.3 Instruction format–instruction fetch and execution–Machine and instruction cycle- T state- (K2)
- 1.4 Addressing modes- Instruction set - data transfer group- arithmetic/logic group (K2)
- 1.5 Branch group - stack and I/O control instruction (K2)
- 1.6 Programming: Picking up Largest / smallest number - Arranging an array in ascending / descending order - Code conversion: Binary to BCD and BCD to Binary, Binary to ASCII, ASCII to Binary and ASCII to BCD and BCD to ASCII (K3, K6)

Unit II: 8085 Microprocessor- Memory and I/O interfacing (12 Hours)

- 2.1 ROM and RAM memory - Memory interface: 2K X 8, 4K x 8 ROM and RAM interface(K2)
- 2.2 8255 Programmable interface I/O –functional Pin configuration- Internal Architecture (K2)
- 2.3 Interfacing of 8255 (K2)
- 2.4 ADC interface - DAC interface - wave form generator (K2, K3, K6)
- 2.5 Hex keyboard interface - 4 step Stepper motor interface (K2, K3, K6)
- 2.6 Traffic regulation interface (K2, K3, K6)

Unit III: 8051 Microcontroller-Architecture, Instruction set and Programming (12 Hours)

- 3.1 Introduction to Microcontroller –8051 Functional pin diagram (K2)
- 3.2 Architecture - Internal registers (K2)
- 3.3 Special function registers -Memory organizations (K2)
- 3.4 Instruction set - Addressing modes (K2)
- 3.5 Programming - Addition and Subtraction -Multiplication and Division (K3, K6)
- 3.6 Arranging an array in ascending/ descending order -Sorting out the maxima and minima (K3, K6)

Unit IV: 8051 Microcontroller - Memory and I/O interfacing (12 Hours)

- 4.1 8051 Input/output Ports (K2, K3)
- 4.2 8051 Interrupts (K2, K3)
- 4.3 Interface 8051 to external memory and I/O devices using its I/O ports (K2, K3)
- 4.4 Counters and Timers –Serial communication using MAX232 (K2, K3)
- 4.5 Interfacing 8051 with ADC –DAC (K2, K3, K6)
- 4.6 LED Display - Hex Keyboard (K2, K3, K6)

Unit V: Sensor Based Embedded Controller &IoT Applications (12 Hours)

- 5.1 Working principle of Sensors/Transducers: Light sensor LDR, Heat sensor LM35, IR Transmitter/ Receiver module (K2)
- 5.2 Embedded system concept–Architecture & salient features of ATmega328 (K2)
- 5.3 Programming & compiling with IDE software - Motor driver IC LM339 (K2, K3)
- 5.4 Blue tooth controller HC05 for wireless communication (K2, K3)
- 5.5 IoT applications for automation : Light activated Morning alarm - Darkness activated Garden Lights - Heat activated Fire alarm (K3, K6)

5.6 Intruder alarm using IR - Android mobile touch key pad controlled Robot car (K3, K6)

Books for Study:

1. R.S. Gaonkar - Microprocessor Architecture, Programming and Application with the 8085, 3rd Edition - Penram International Publishing, Mumbai, 1997.
2. V.Vijayendran - Fundamentals of Microprocessor 8085 - Architecture, Programming and interfacing - Viswanathan Publication, Chennai, 2002.
3. N. NagoorKanni- Microprocessor and Microcontroller –2nd Edition - Tata McGraw Hill EducationPvt. Ltd., New Delhi, 2017.
4. Muhammed Ali Mazidi and Janice Gillespie Mazidi- The 8051 Microcontroller and Embedded Systems, Fourth Indian Reprint - Pearson Education, 2004.
5. Kenneth J. Ayala - The 8051 Micro Controller Architecture, Programming and Applications, 3rd Edition - West Publishing Company, 1991.

Books for Reference:

1. B. Ram - Fundamentals of Microprocessors and Microcomputers – DhanpatRaiPublications, New Delhi, 2005.
2. R. Thiagarajan, S. Dhanasekaran and S.Dhanapal - Microprocessor and its Applications, New Age International, New Delhi, 2010.
3. John B. Peatman - Design with PIC Microcontrollers, 7th Indian Reprint – Pearson Education, 2004.
4. Raj Kamal - Introduction to Embedded Systems - TMS, 2002.

SEMESTER III

PEPHE20 - NUMERICAL METHODS AND C-PROGRAMMING

Year: II Sem: III	Course Code: PEPHE20	Title of the Course: Numerical Methods and C-Programming	Course Type: Theory	Course Category: Core Elective	H/W 5	Credits 4	Marks 100
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Course Objectives

1. To impart the knowledge of numerical methods for solving problems arise in physics
2. To equip the students with the skill of C language.

Course Outcomes (CO)

The learners will be able to

1. Understand and apply numerical concepts to solve equations and find missing values for any physical problems
2. Solve ordinary differential equations using numerical techniques
3. Understand the basic concepts of C Language
4. Understand and use various operators and arrays in C Language
5. Develop simple programs using C language along with computational tools

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	M	L	L
CO2	H	H	H	M	L	L
CO3	H	L	L	M	M	M
CO4	H	L	L	H	M	M
CO5	H	M	M	H	M	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	L	L
CO2	H	H	H	M	M	M
CO3	H	H	L	M	M	M
CO4	H	H	M	L	L	L
CO5	H	H	M	M	M	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Solution of Equations and Interpolation (14 Hours)

- 1.1 Methods of false position (K2, K3, K4, K5)
- 1.2 Newton's method (K2, K3, K4, K5)
- 1.3 Fixed point - Iteration method (K2, K3, K4, K5)
- 1.4 Interpolation - Lagrangian polynomials (K2, K3, K4, K5)
- 1.5 divided differences (K2, K3, K4, K5)
- 1.6 Newton's forward and backward difference formulae (K2, K3, K4, K5)

Unit II: Numerical Differentiation, Integration and Differentiation Equations(16 Hours)

- 2.1 Derivatives - Newton's forward / backward interpolation and Stirling formula (K2, K3, K4, K5)
- 2.2 Numerical integration by Trapezoidal Solutions of equations (K2, K3, K4, K5)
- 2.3 Simple iterative methods - Newton method (K2, K3, K4, K5)
- 2.4 Numerical Integration - Simpsons 1/3 and 3/8 rules (K2, K3, K4, K5)
- 2.5 Solution to first order differential equations: Taylor series method (K2, K3, K4, K5)
- 2.6 Euler and modified Euler methods - Runge-kutta method (K2, K3, K4, K5)

Unit III: Programming in C (13 Hours)

- 3.1 Introduction - Basic structure of C Programming (K1, K2)
- 3.2 Character set - Key words (K1, K2)
- 3.3 Identifiers (K1, K2)
- 3.4 Variables (K1, K2)
- 3.5 Assigning values to variables (K1, K2)
- 3.6 Symbolic constant (K1, K2)

Unit IV: Operators, Arrays and Strings (14 Hours)

- 4.1 Operators - Arithmetic, relational, logical, assignment, increment (K1, K2)
- 4.2 Decrement conditional and special type conversion in Expressions (K1, K2)
- 4.3 Arrays - Multi dimensional arrays(K1, K2)
- 4.4 Initializing two dimensional arrays (K1, K2)
- 4.5 Initializing string variables (K1, K2)
- 4.6 Reading and writing Strings on the Arithmetic operations on strings (K1, K2)

Unit V: Simple Programmes (15 Hours)

- 5.1 User defined functions - their needs - Multi function programme (K3, K6)
- 5.2 Return values and their types - Calling functions (K3, K5, K6)
- 5.3 Categories of functions - Multiplication (K3, K5, K6)
- 5.4 Diagonalization and inversion - Solution and C programming (K3, K5, K6)
- 5.5 Lagrangian interpolation - Simpson's rule (K3, K5, K6)
- 5.6 Euler method- Runge- Kutta method (K3, K5, K6)

Books for Study:

1. T. Veerarajan and T. Ramachandran, Numerical Methods with Programming in C, Second

Edition, Tata McGraw Hill, 2007

2. E. Balagurusamy - Computing Fundamentals and Programming, ANSI C, 3rd Edition - Tata McGraw Hill Education, Ltd., 2014.
3. G. Balaji - Numerical Methods, 9th Edition - G. Balaji Publishers, Chennai, 2008.

Books for Reference:

1. S. Kalavathy, M. JoicePunitha - Numerical Methods, 2nd Edition - Vijay Nicole imprints Pvt. Ltd.,2010.
2. Kandasamy P., K. Thilagavathy and K. Gunavathy, Numerical Methods, S. Chand Co. Ltd., New Delhi, 2003.
3. A. Singaravelu, Numerical Methods, Meenakshi Agency, 2016.

SEMESTER III

PIPHF20 - IEP: NUMERICAL METHODS & RESEARCH METHODOLOGY

Year: II Sem: III	Course Code: PIPHF20	Title of the Course: IEP: Numerical Methods and Research Methodology	Course Type: Theory	Course Category: Independent Elective	H/W -	Credits 2	Marks 100
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Course Objectives

1. To impart knowledge of various concepts involved in numerical analysis
2. To prepare the students for higher studies

Course Outcomes (CO)

The learners will be able to

1. Understand and apply numerical concepts to solve equations and evaluate any integrals
2. Solve ordinary differential equations using numerical differentiation techniques
3. Understand the basics of research and research methodology
4. Define research problem in their own domain and describe various research design
5. Draw a good research report and impart research communication techniques

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	M	H	L
CO2	H	M	H	M	M	L
CO3	H	L	L	L	M	H
CO4	H	H	M	M	L	H
CO5	H	H	L	M	H	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	H
CO2	H	H	M	H	M	M
CO3	M	H	M	H	H	H
CO4	H	M	H	M	M	M
CO5	M	M	H	M	M	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Solution of Equations and Numerical Integrations (14 Hours)

- 1.1 Fixed point iteration method (K2, K3, K4, K5)
- 1.2 Newton's Raphson method (K2, K3, K4, K5)
- 1.3 Solutions of simultaneous equation (K2, K3, K4, K5)
- 1.4 Numerical integration using Trapezoidal(K2, K3, K4, K5)
- 1.5 Simpson's 1/3 rule (K2, K3, K4, K5)
- 1.6 Simpson's 3/8 rule (K2, K3, K4, K5)

Unit II: Numerical Differentiations (14 Hours)

- 2.1 Solutions of equations (K2, K3, K4, K5)
- 2.2 Numerical Differentiation (K2, K3, K4, K5)
- 2.3 Numerical solution of first order differential equations (K2, K3, K4, K5)
- 2.4 RungeKutta method (K2, K3, K4, K5)
- 2.5 Taylor series method (K2, K3, K4, K5)
- 2.6 Euler's and modified Euler's method (K2, K3, K4, K5)

Unit III: Research Methodology - An Introduction (13 Hours)

- 3.1 Meaning of research - Objectives of research (K1, K2)
- 3.2 motivation of research (K1, K2)
- 3.3 Types, approaches and significance - Methods versus methodology (K1, K2)
- 3.4 Research in scientific methods - Research process (K1, K2, K3, K5)
- 3.5 Criteria for good research - Problem encountered by research in India-(K1, K2, K4)
- 3.6 Funding agencies (K1, K2)

Unit IV: Research Design (15 Hours)

- 4.1 Identification of the problem - Literature Survey (K1, K2, K6)
- 4.2 Reference Collection (K1, K6)
- 4.3 Necessity and techniques involved in defining the problem (K1, K2, K4)
- 4.4 Research design - Needs and features of good design (K3, K4, K5)
- 4.5 Different research design (K3, K4, K5, K6)
- 4.6 Basic principles of experimental designs (K1, K2)

Unit V: Research Communication (16 Hours)

- 5.1 Meaning of research report - Logical format for writing thesis and paper (K1, K2)
- 5.2 Essential of scientific report: abstract, introduction (K1, K2)
- 5.3 Review of literature, materials and methods and discussion - The use of quotation (K1, K2)
- 5.4 Footnotes - tables and figures - referencing - appendixes - revising the paper or thesis (K2, K6)
- 5.5 Oral power point presentation - Poster preparation (K1, K2, K6)
- 5.6 Editing and evaluating and the final product - proof reading - the final types copy (K1, K2, K6)

Books for Study:

1. Dr. G. Balaji - Numerical Methods 15th edition - G.Balaji Publishers-2017
2. E. Balagurusamy - Numeric Methods - Tata Mc Graw Hill.
3. C.R. Kothari and Gaurav Garg - Research Methodology, Methods and Techniques - New age International Publishers, III Edition. 2014
4. Santosh Gupta - Research Methodology Methods and Statistical Techniques
5. Rajammal et al., -A hand Book of Methodology of Research - Sri Ramakrishna Mission Vidyalaya Press, Coimbatore.

Books for Reference:

1. C.Hawkins& M Sorgi - Research Ed Norosa Publishing House, New Delhi - 2000
2. Robert Ross - Research: An introduction - - Harper and Row Publications.
3. P. Saravanavel - Research methodology - - KitlabMahal, Sixth Edition.
4. R.A. Day - How to write and publish a scientific paper - Cambridge University Press.
5. Anderson - Thesis and Assignment writing - - Wiley Eastern Ltd.

SEMESTER IV

PCPHP20 - PRACTICAL- IV MICROPROCESSOR, MICROCONTROLLER AND C PROGRAMMING

Year: II Sem: IV	Course Code: PCPHP20	Title of the Course: Microprocessor, Microcontroller & C-Programming	Course Type: Practical	Course Category: Core	H/W 4	Credits 4	Marks 100
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Course Objectives

1. To provide the students hands on training of programming knowledge on Microprocessor, Microcontroller and C language.
2. To make the students develop the assembly language programs for arithmetic and peripheral interface operations.

Course Outcomes (CO)

The learners will be able to

1. Develop assembly language programs on arithmetic and sorting operations using 8085 and 8051
2. Develop and perform peripheral interface programs with 8085 Microprocessor
3. Perform all code conversions and analog signals into digital and vice versa. Also can generate wave forms.
4. Write C program for any basic operations
5. Solve any physical problems using C language along with numerical techniques

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	H	M	H	M
CO2	H	M	L	H	H	M
CO3	H	M	L	L	M	M
CO4	H	L	M	M	M	M
CO5	H	M	M	H	H	M

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	M
CO2	H	H	M	H	M	M
CO3	H	M	L	L	M	M
CO4	H	H	M	M	M	M
CO5	H	H	M	H	M	M

(Low - L, Medium – M, High - H)

Course Syllabus

(Any 20 experiments)

Microprocessor 8085 Programmes (K1 - K6)

1. Addition & subtraction and Multiplication & Division of 8-bit hexadecimal numbers.
2. Square and Square Root of 8-bit hexadecimal numbers.
3. Picking up Largest and Smallest number in an array of 8-bit hexadecimal numbers.
4. Arranging an array of 8-bit hexadecimal numbers in Ascending and Descending orders.
5. Code Conversion of Binary to BCD and BCD to Binary, Binary to ASCII and ASCII to Binary and BCD to ASCII and ASCII to BCD.
6. 8-Bit and 16-Bit BCD Addition.
7. Addition of Array of 8-Bit Numbers.
8. Digital Clock Program for 12 / 24 Hours.
9. Analog to Digital Conversion and ADC Interface.
10. Digital to Analog Conversion - Wave form Generator - DAC Interface.
11. Keyboard Display Interface.
12. Stepper Motor Interface.
13. Traffic regulation interface
14. Dynamic message display
15. 8255 I/O Display interface

Microprocessor 8086 Programmes

1. 16-Bit Addition & subtraction and Multiplication & division.
2. 16-Bit Ascending and descending order.
3. Computation of LCM.
4. Factorial of a number.

Microcontroller 8051 Experiments

1. 8-Bit Addition and Subtraction
2. 8-Bit Multiplication and Division.
3. Sorting in ascending and descending order.
4. Sorting out the maxima and minima.

Computation Methods - C Programming

1. Lagrange interpolation with algorithm, flow chart with program and its output

2. Numerical integration by Simpson's rule with algorithm and flowchart with program and its output.
3. Numerical solution of ordinary first order differential equation -Euler's method with algorithm, flowchart and its output.
4. Numerical solution of ordinary first order differential equations by the Runge- kutta method, with algorithm, flow chart with program and its output
5. Curve fitting - Least square fitting with algorithm, flowchart and its output.

SEMESTER IV

PEPHG20 - ELECTIVE IV A: FIBER OPTICS AND NON-LINEAR OPTICS

Year: II	Course Code:	Title of the Course:	Course Type:	Course Category:	H/W	Credits	Marks
Sem: IV	PEPHG20	Fibre Optics and Non-Linear Optics	Theory	Major Elective	5	4	100

Course Objectives

1. To make the students understand the concepts of fiber optics, Non linear optics and their applications.

Course Outcomes (CO)

The learners will be able to

1. Understand the basic principles and concepts in optical fiber and describe the properties of optical sources.
2. Distinguish between the various types and the characteristics of optical fiber.
3. Analyze and comparing the different fabrication process of fiber.
4. Describe various losses and connectors in optical fiber.
5. Understand non-linear effects in optical fiber and their applications.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	M	H	H	M
CO2	H	H	M	H	M	M
CO3	H	H	H	M	H	H
CO4	H	H	L	H	M	M
CO5	H	H	L	M	H	H

CO	PO					
	1	2	3	4	5	6
CO1	M	H	H	H	M	H
CO2	H	H	H	M	M	M
CO3	H	M	M	H	H	H
CO4	H	H	H	M	H	M
CO5	M	H	M	H	M	H

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Optical fiber waveguides and sources

(13 hours)

- 1.1 Ray theory transmission: Total internal reflection, acceptance angle, numerical aperture and skew rays (K1, K2, K3, K6)
- 1.2 Phase shift with total internal reflection and the evanescent field -Goos- Haechen shift (K1, K2, K3)
- 1.3 Sources: LED-structure - Light source materials - Quantum efficiency and LED power - Modulation of LED - Transient response (K1, K2, K5)
- 1.4 Laser diode modes and threshold conditions for laser oscillations (K1, K2, K3)
- 1.5 Laser diode structures and radiation patterns(K1, K2, K6)
- 1.6 Modulation of laser diode –Temperature effects - Mode locking laser - Light source linearity and reliability (K1, K2, K3)

Unit II: Types of Optical Fibers

(11 Hours)

- 2.1 Glass and plastic fibers - Step index - single mode - Multimode - Graded index fibers- wave propagation (K1, K2)
- 2.2 Fiber modes - Step index single mode fiber- step index multimode fiber - Graded index multimode fiber (K1, K2, K3)
- 2.3 Single mode fibers- cutoff wavelength - mode field diameter and spot size - effective refractive index (K1, K2, K3)
- 2.4 Fiber loss - Attenuation coefficient - Material absorption losses in silica glass fibers- Intrinsic and extrinsic absorption (K1, K2, K4)
- 2.5 Linear Scattering losses - Rayleigh scattering - Mie scattering - Non linear Scattering losses - Stimulated Brillouin scattering - Stimulated Raman scattering (K1, K2, K3)
- 2.6 Fiber bend loss - Intermodal dispersion - Multimode step index - Multimode graded index - Modal noise - Overall fiber dispersion - Multimode - single mode fibers (K3, K4, K5)

Unit III: Fabrication and Connection of Optical Fibers

(11 Hours)

- 3.1 Glass fibers - Preparation of optical fibers(K1, K2)
- 3.2 Liquid-phase (melting) technique - fiber drawing (K1, K2)
- 3.3 Vapour-phase deposition techniques - outside vapour phase deposition (K1, K2, K3)
- 3.4 Modified chemical vapour deposition (K1, K2, K3, K4)
- 3.5 Plasma activated chemical vapour deposition (K2, K3, K5)
- 3.6 characteristics of single-mode, multimode, plastic-clad and all-plastic fibers(K4, K5, K6)

Unit IV:Transmission Characteristics

(12 Hours)

- 4.1 Stability of Fiber Transmission Characteristics: Micro bending and hydrogen absorption (K1, K2)
- 4.2 fiber alignment and joint loss - Single mode fiber- Multimode fiber(K1, K2, K3)
- 4.3 fiber splices - Tube splices, Fusion splices (K2, K3, K4)
- 4.4 Mechanical Splices (K4, K5, K6)
- 4.5 Fiber connectors: cylindrical ferrule expanded beam connectors - GRIN rod lenses (K3, K5, K6)
- 4.6 Fiber couplers: Three and four port couplers - star couplers (K4, K5, K6)

Unit V: Nonlinear Optics and Solitons

(13 Hours)

- 5.1 Wave propagation in an anisotropic crystal - Polarization response of materials to light (K1, K2)
- 5.2 Second order non-linear optical processes - Sum and difference frequency generation (K1, K2)
- 5.3 Third order nonlinear optical processes - third harmonic generation (K1, K2)
- 5.4 Intensity dependent refractive index - self-focusing - self defocusing - Phase matching –four wave mixing (K1, K3)
- 5.5 Concept of solitons - formation of solitons- kdV equation (K1, K2, K4, K5)
- 5.6 Nonlinear Schrödinger equation for solitons - soliton switching - soliton laser- advantages of soliton based communication (K1, K2, K5, K6)

Books for Study:

1. John M. Senior - Optical Fiber Communications: Principles and Practice, 2nd Edition - PHI, 2011.
2. Ajoy Ghatak and K. Thyagarajan - Introduction to Fiber Optics, 6th Edition - Cambridge University Press, 2006.
3. Gerd Keiser - Optical Fiber Communications, 4th Edition - McGraw Hill, 2012.
4. B.B. Laud - Lasers and Non-Linear Optics - New Age International, New Delhi, 2011.
5. William T. Silfvast, Laser fundamentals, Cambridge university press, Cambridge 2003.

Books for Reference:

1. Akira Hasegawa and Yuji Odama - Solitons in Optical Communications - Oxford Press, 1995.
2. Robert W Boyd - Nonlinear Fiber Optics, 2nd Edition - Elsevier, 2006.
3. Govind P. Agrawal - Fiber Optic Communication Systems - John Wiley, 2003.
4. M Remoissenet - Waves Called Solitons: Concepts and Experiments, Springer Verlag, 1992.
5. B.B. Laud - Lasers and Nonlinear Optics, 2nd Edition - New Age International (P) Ltd., New Delhi, 1991.

SEMESTER IV

PEPHH20 - ELECTIVE IV B: ADVANCED MATERIAL SCIENCE

Year: II	Course Code:	Title of the Course:	Course Type:	Course Category:	H/W	Credits	Marks
Sem: IV	PEPHH20	Advanced Material Science	Theory	Major Elective	5	4	100

Course Objectives

1. To impart knowledge about crystallography and wide knowledge about properties of materials.

Course Outcomes (CO)

The learners will be able to

1. Understand the building unit of structure of crystal and their symmetry.
2. Interpret about the magnetic properties and effects on materials
3. Attain the knowledge of superconducting materials and problem solving.
4. Pick up the ideas in lasing action, optical resonators and its applications.
5. Get introduced all about smart, nano and magnetic materials and its application useful to carry out the research work and fabricating the devices for public utility.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	L	M	H	H
CO2	H	H	L	H	M	H
CO3	H	H	H	H	L	H
CO4	H	H	L	H	M	M
CO5	H	H	L	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	M	H	M	M	H
CO2	M	H	M	H	H	M
CO3	H	H	M	H	H	M
CO4	H	M	M	M	H	M
CO5	M	H	H	M	M	H

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Applied Crystallography in Material Science

(10 Hours)

- 1.1 Crystal systems, unit cells (K1, K2)
- 1.2 Indices of lattice directions and planes (K1, K2)
- 1.3 co-ordinates of position in the unit cell - Crystal geometry (K1, K2, K3)
- 1.4 Symmetry classes and point groups, space groups (K2, K3)
- 1.5 Glide planes and screw axes, space group notations, equivalent points (K2, K3, K4)
- 1.6 Systematic absences - Determination of crystal symmetry from systematic absences (K3, K4, K5)

Unit II: Magnetism

(9 Hours)

- 2.1 Principles of magnetic measurements (K1, K2, K3)
- 2.2 Basic ideas of measuring M, χ , and T_c (K1, K2)
- 2.3 Magneto thermal effect - magneto resistance (K1, K2)
- 2.4 Magneto optical phenomena - magneto acoustic effect (K2, K3, K4)
- 2.5 Magneto optic recording (K2, K3, K4)
- 2.6 Importance of magnetic anisotropy (K3, K4, K5, K6)

Unit III: Superconductivity

(10 Hours)

- 3.1 Introduction - critical parameters (K1, K2)
- 3.2 Anomalous characteristics - isotope effect, Meissner effect (K1, K2, K3)
- 3.3 Type I and II superconductors - BCS theory (K2, K3)
- 3.4 Josephson junctions and tunneling- SQUID (K3, K4, K5)
- 3.5 High temperature superconductors, crystallographic and structural properties of high temperature superconductors (K1, K2, K3)
- 3.6 Dependence of T_c on crystal structures - applications (K1, K2, K3, K4)

Unit IV: Laser Theory and Applications

(9 Hours)

- 4.1 Introduction - Einstein's coefficient (K1, K2)
- 4.2 Threshold condition for laser action - optical pumping (K1, K2, K3)
- 4.3 Resonant cavities, spot size - types of resonator, quality factor of an optical resonator (K1, K2, K3)
- 4.4 Welding, drilling and hardening (K3, K4)
- 4.5 Advantages and uses of laser in material processing (K1, K2, K3)
- 4.6 Applications (K1, K2)

Unit V: Technological materials

(10 Hours)

- 5.1 Metallic glasses - preparation properties and applications (K1, K2)
- 5.2 SMART materials - Piezoelectric, magnetostrictive, electrostrictive materials (K1, K2, K3)
- 5.3 CCD device materials - applications (K1, K2, K3)
- 5.4 Solar cell materials (single crystalline, amorphous and thin films) (K2, K3, K4)
- 5.5 Introduction to nanophase materials (K2, K3, K4)

5.6 Properties of nanophase materials (K1, K2, K3)

Books for study:

1. V. Raghavan - Material science and Engineering, Prentice Hall ,2003
2. C. Kittel - Introduction to Solid State Physics - Wiley and Sons Ltd., New York. 2015.
3. M.Tinkham- Introduction to superconductivity- Rhinehard and Winton New York, 1996
4. Charles P.Poole- Introduction to Nanotechnology - Wiley inter science, 2003
5. M.N. Avadhanulu- An introduction to lasers, theory & applications - S. Chand & Co. New Delhi. 2001.
6. B.D. Cullity - Introduction to magnetic materials - Addison - Wesley, 1972.

Books for reference:

1. M.Ali Omar- Elementary Solid State Physics- Revised Printing Pearson Edn., 2000.
2. J. Dekker - Solid state Physics - Prentice Hall, 1957.
3. Oshea and Co. - An Introduction to lasers and their applications - Addison Wesley, 1969.
4. C.N.R. Rao- Chemistry of High temperature superconductors - World Scientific, 1991.
5. C.R.M. Grovenor and Co. Microelectronic materials - Adam hilger, Philadelphia, 1989.

SEMESTER IV

PIPHG20 - IEP: PHYSICS FOR SET/NET - PAPER IV

Year: II	Course Code:	Title of the Course:	Course Type:	Course Category:	H/W	Credits	Marks
Sem: IV	PIPHG20	IEP: Physics for SET/NET – Paper IV	Theory	Independent Elective	-	2	100

Course Objectives

1. To impart knowledge about Nuclear & Particle Physics, Numerical Methods and Condensed matter Physics for competitive Examinations.

Course Outcomes (CO)

The learners will be able to

1. Understand the basic properties of nucleus and nuclear models.
2. Gain the knowledge about the elementary particles and quantum numbers.
3. Impart knowledge of finding solutions to any differential equations and Interpolation by using Newton's method, Simpson's and Trapezoidal rules.
4. Attain the basic concepts and theories in crystals and magnetism and develop the skills to solve the problems in the respective filed for performing higher studies and research.
5. Understand the basic concepts in superconductors.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	M	M	L
CO2	H	H	H	M	M	M
CO3	H	H	H	H	L	L
CO4	H	H	M	M	M	H
CO5	H	H	M	H	L	H

CO	PO					
	1	2	3	4	5	6
CO1	H	M	M	M	M	L
CO2	H	M	M	M	M	L
CO3	H	H	H	H	L	L
CO4	H	H	H	H	M	M
CO5	H	M	M	H	L	M

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Nuclear and Particle Physics – I

- 1.1 Basic nuclear properties - size, shape and charge distribution (K1, K2,)
- 1.2 Spin and parity - Binding energy - Ground state of deuteron (K1, K2, K3)
- 1.3 Nuclear reactions - Types of reactions - Conservation laws (K1, K2, K3, K4)
- 1.4 Q-value equation - Nuclear models - Liquid drop (K2, K3, K4)
- 1.5 Semi empirical mass formula - Shell model (K3, K4,)
- 1.6 Magic numbers - Angular momentum and parity - Collective model (K3, K4, K6)

Unit II: Nuclear and Particle Physics –II

- 2.1 Nuclear decay - alpha - beta decays (K1, K2)
- 2.2 Gamma decays - Selection rules (K1, K2)
- 2.3 Elementary particles - Symmetries (K2, K3)
- 2.4 Conservation laws - CPT invariance - Quark model (K2, K3, K4)
- 2.5 Baryons and mesons - Fission and Fusion (K2, K3, K4)
- 2.6 Nuclear reactions - Elementary particles and their quantum numbers (K4, K5, K6)

Unit III: Numerical Methods

- 3.1 Derivatives - Newton's forward / backward interpolation and (K1, K2, K3)
- 3.2 Stirling formula, Numerical integration by Trapezoidal Solutions of equations (K2, K3, K4)
- 3.3 Numerical methods - Regular falsi(K3, K4, K5)
- 3.4 Newton's method - Lagrangian Interpolation (K3, K4, K5)
- 3.5 Newton's divided difference method - Trapezoidal - Simpson's rule (K3, K4, K5)
- 3.6 Solution of differential equations by Runge-Kutta method (K4, K5, K6)

Unit IV: Condensed Matter Physics

- 4.1 Bravais lattices - Reciprocal lattices and Brillouin zones ((K1, K3, K4, K5)
- 4.2 Crystal diffraction - Bragg's law - Crystal diffraction techniques (K3, K4, K5)
- 4.3 Bonding of solids - Lattice specific heat - Phonons (K4, K5)
- 4.4 Einstein's and Debye's theory of specific heat - Free electron gas - Hall effect (K1, K2, K3)
- 4.5 Bloch theorem - Kronig Penny Model - Semiconductors (K1, K2, K3)
- 4.6 Elementary ideas of dia, para and ferro magnetism (K1, K2, K3)

Unit V: Superconductors

- 5.1 Superconductors - Properties of superconductor - Experimental facts - occurrence - Effect of magnetic fields - Meissner effect - Entropy and heat capacity (K1, K2)
- 5.2 Energy gap - Type I and II Superconductors - Josephson Effect (K1, K2, K3)
- 5.3 London equation - Theoretical explanation (K1, K2, K4)
- 5.4 Thermodynamics of Super conducting transition - London equation - BCS theory (K2, K3, K4)
- 5.5 Coherence length - Theory - Single particle tunneling(K3, K4, K5)
- 5.6 High temperature superconductors and applications (K4, K5)

Books for Study:

1. M.L. Pandya and R.P.S. Yadav - Elements of Nuclear Physics, KedarNathRamNath, Delhi,2005.
2. D. C. Dayal - Nuclear Physics University of Chicago Press Chicago.; Revised Edition, 6th Printing edition(1956)
3. D. Griffiths - Introduction to Elementary Particle Physics, Harper & Row, New York, 1987
4. S.O. Pillai - Solid State Physics, New Age International Publishers, New Delhi,2017.
5. Gupta Kumar Sharma - Solid statePhysics
6. C. Kittel - Introduction to Solid State Physics, Wiley & Sons Ltd., New York.2012.
7. Dr.SurekhaTomar - Competitive Exams for CSIR - UGC NET/JRF/SET - Upkar's publications.
8. M.K. Venkataraman. - Introduction to NumericalMethods

Book for reference:

1. K.S. Krane - Introductory Nuclear Physics , Wiley, New York,1987.
2. J.K. Bhattacharjee - Statistical Mechanics an Introductory text - AlliedPublishers Ltd., New Delhi, 1996.
3. Charles Kittel, Elementary Statistical Physics - Dover Publications, Inc, NewYork, 2004.
4. M. Glazer and J. Wark - Statistical Mechanics - Oxford UniversityPress.
5. C. Kalidas, M.V.Sangaranarayanan - Non - Equilibrium Thermodynamics - Macmillan India, New Delhi.