Department of Physics (PG)

SYLLABUS AND REGULATIONS

Under

OUTCOME-BASED EDUCATION

2020

(Effective for the Batch of Students Admitted from 2020-2021)

AUXILIUM COLLEGE (Autonomous)

(Accredited by NAAC with A+ Grade with a CGPA of 3.55 out of 4 in the 3rd Cycle)

Gandhi Nagar, Vellore-632 006

Department of Physics (PG)

OUTCOME BASED EDUCATION - 2020

(Effective for the Batch of Students Admitted from 2020-2021)

A) INSTITUTION LEVEL

Vision

The vision of the college is to educate young women especially the poorest to become empowered and efficient leaders of integrity for the society.

Mission

To impart higher education to the economically weak, socially backward and needy students of Vellore and neighbouring districts.

B) NAME OF THE PROGRAMME: PG PHYSICS

Vision

To empower the young women by offering higher education which promotes interest and thirst for research in the field of Physical sciences.

Mission

- To provide quality education through well designed programs
- To impart knowledge in various areas of Physical sciences related to research.
- To undertake research oriented projects.

C) ELIGIBILITY CRITERIA OF THEPROGRAMME:

Students who have completed B.Sc., Physics are eligible.

D) **LIST OFCOURSES**

Sem.	Part	Code	Title of the Paper	Hours/ Week	Exam		Credits	Marks
					Th	Pr		
I		PCPHA20	Mathematical Physics – I	6	3	-	5	40+60
		PCPHB20	Classical Mechanics	6	3	-	5	40+60
		PCPHC20	Statistical Mechanics	6	3	-	4	40+60
		PCPHG20	Practical I: General	3	-	-	-	-
		PCPHH20	Practical II: Electronics	3	-	-	-	-
		PEPHA20	Elective I A: Electronic Devices and Applications	6	3	-	4	40+60
		PEPHB20	Elective I B: Electronic Communication Systems.					
		PIPHA20	IEP: Physics For Set/Net – Paper I	-	3	-	2	40+60
		PIPHB20	IEP: Astro Physics					
			Total	**30**			**20**	**500**
II		PCPHD20	Mathematical Physics – II	6	3	-	5	40+60
		PCPHE20	Electromagnetic Theory	6	3	-	5	40+60
		PCPHF20	Quantum Mechanics – I	6	3	-	4	40+60
		PCPHG20	Practical I: General	3	-	4	4	40+60
		PCPHH20	Practical II: Electronics	3	-	4	4	40+60
		PEPHC20	Elective II A: Crystal Growth, Nano Science and Research Methodology	4	3	-	4	40+60
		PEPHD20	Elective II B:.Electronic Instrumentation					
		PNHRA16	Human Rights	2	3	-	2	40+60
		PIPHC20	IEP: Physics For Set/Net - Paper II	-	3	-	2	40+60
		PIPHD20	IEP: Medical Physics and Instrumentation Techniques					
			Total	**30**			**30**	**800**
III		PCPHI20	Spectroscopy	6	3	-	4	40+60
		PCPHJ20	Quantum Mechanics –II	6	3	-	4	40+60
		PCPHK20	Microprocessor and Micro-controller	6	3	-	4	40+60
		PCPHO20	Practical III: General	4	-	-	-	-

		PCPHP20	Practical IV: Microprocessor, Microcontroller & C-Programming	4	-	-	-	-
		PEPHE20	Elective III A: Numerical Methods and C Programming	4	3	-	4	40+60
		PEPHF20	Elective III B: Advanced Optics					
		PGTRA16	Teaching and Research Aptitude		3	-	3	40+60
		PIPHE20	IEP: Physics For Set/Net - Paper III	-	3	-	2	40+60
		PIPHF20	IEP: Numerical Methods & Research Methodology					
		PSPHA20	Summer Project – Viva Voce				3	40+60
			Total	**30**			**24**	**700**
IV		PCPHL20	Material Science and Laser Physics	6	3	-	5	40+60
		PCPHM20	Nuclear Physics and Particle Physics	6	3	-	4	40+60
		PCPHN20	Condensed Matter Physics	6	3	-	4	40+60
		PCPHO20	Practical III: General	4	-	4	4	40+60
		PCPHP20	Practical IV: Microprocessor, Microcontroller & C-Programming	4	-	4	4	40+60
		PEPHG20	Elective IV A: Fibre Optics and Non-Linear Optics	4	3	-	4	40+60
		PEPHH20	Elective IV B: Advanced Material Science					
		PIPHG20	IEP: Physics For Set/Net - Paper IV	-	3	-	2	40+60
		PIPHH20	IEP**:** Advanced Nuclear Physics & Spectroscopy					
			Total	**30**			**27**	**700**
			Grand Total				**101**	**2700**

E) Program Objectives (POs) (After 3-5 years of graduation)

PO1: Attain an in-depth knowledge in the respective domains augmented through self-learning.

PO2: Assimilate and apply principles and concepts towards skill development and employability.

PO3: Apply critical and scientific approaches to address problems and find solutions.

PO4: Develop research skills through multi/inter/trans-disciplinary perspectives.

PO5: Integrate issues of social relevance in the field of study.

PO6: Persist in life-long learning for personal and societal progress.

F) Program Specific Outcomes (PSOs):

PSO1: Attain in depth knowledge on various areas of Physics.

PSO2: Understand the various methods in the respective field.

PSO3: Inculcate the mathematical concepts for solving problems.

PSO4: Gain knowledge about various applications.

PSO5: Become Skilled to face competitive examinations.

PSO6: Attain interest for higher education and research.

PSO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	H	H	M	H	H	M
PSO2	H	H	M	H	H	H
PSO3	H	H	M	H	H	H
PSO4	H	H	M	H	H	H
PSO5	H	H	H	H	H	M
PSO6	H	H	H	H	M	H

H– Strongly Correlated
M– Moderately Correlated
L–Weakly Correlated

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

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

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

Course Objectives

1. To understand thefundamental 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, paramagnetismetc.)
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 -Landu'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. Ilangovan - 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

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 - Schimitt 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 - Schimitt 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 &
3. Publishers), Pvt. Ltd., 2007.
4. Amar K.Ganguly - Optoelectronic Devices and Circuits - Narosa Publishing House, 2007.
5. 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, Driscol - 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 SupriyoDattaOrganic field-effect transistors by Bao Z., Locklin J. (eds.)

SEMESTER I

PEPHB20 - ELECTIVE IB: ELECTRONIC COMMUNICATION SYSTEMS

Year: I **Sem:** I	**Course Code:** PEPHB20	**Title of the Course:** Electronic Communication Systems	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 4	**Marks** 100

Course Objectives

1. To make the students acquire knowledge about electronic communication systems.
2. To understand the error control coding for encoding and decoding digital data.
3. To access the analog and digital technologies used for satellite communication networks.
4. To impart to the students the basic understanding of wireless network system.

Course Outcomes (CO)

The learners will be able to

1. Compare the performance of AM, FM and PM schemes with reference to SNR.
2. Design encoder and decoder schemes for error control.
3. Understand the orbital and functional principles of satellite communication systems.
4. Understand the evolution of cellular communication systems up to and beyond 3G.
5. Understand fundamentals of wireless communications.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	L	H	M	M	L	H
CO2	M	L	H	L	M	M
CO3	H	M	L	M	H	H
CO4	H	L	M	L	H	H
CO5	H	M	L	H	M	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: Signal Encoding Techniques **(14 Hours)**

1.1 Line of sight transmission - Fading in the mobile environment (K2, K3)
1.2 Antennas: types - Propagation modes (K1, K2)
1.3 Signal encoding techniques: criteria (K1, K2)
1.4 ASK - FSK - BFSK - MFSK - PSK - BPSK - QPSK (K1, K2)
1.5 Multilevel PSK - AM modulation - Angle modulation (K1, K2)
1.6 PCM - delta and adaptive delta modulation (K1, K2)

Unit II: Coding and Error Control **(14 Hours)**

2.1 Error detection - Parity check - cycle redundancy check (K3, K4, K5)
2.2 Block error correction codes - hamming code (K1, K4, K5)
2.3 Cyclic codes - BCH code - reed - Solomon codes(K3, K4, K5)
2.4 Block interleaving –convolution codes - decoding (K4, K5)
2.5 Turbo coding - automatic repeat request (K4, K5)
2.6 Flow control - error control (K4, K5)

Unit III: Satellite Communication **(15 Hours)**

3.1 Satellite parameters and configurations (K1, K2)
3.2 Satellite orbits - GEO - MEO - LEO (K1, K2)
3.3 Frequency bands - transmission impairments (K2, K3)
3.4 Satellite foot print - atmospheric attenuation (K2)
3.5 Satellite network - configuration - capacity allocation (K2, K3, K4)
3.6 Multiplexing: FDM and TDM (K1, K2)

Unit IV: Cellular Wireless Networks **(16 Hours)**

4.1 Principles of cellular networks: Organization - frequency reuse (K1, K2)
4.2 Operation - mobile radio propagation effects - hand-off (K2, K3, K4)
4.3 Power control - traffic engineering - first generation analog(K3, K4, K5)
4.4 AMPS - second generation - TDMA - mobile wireless TDMA design consideration (K2, K3)
4.5 CDMA - mobile wireless CDMA design considerations (K3, K4, K5)
4.6 Soft handoff –IS 95 - Third generation systems - wireless local loop (K1, K2)

Unit V: Wireless LANS **(13 Hours)**

5.1 Overview: Wireless LAN applications - wireless LAN requirements (K1, K2, K3)
5.2 Wireless LAN technology - Infrared LANS (K1, K2)
5.3 Spread spectrum LANS (K2, K3, K4)
5.4 Narrow band microwave LANS (K1, K2)
5.5 IEEE 802 architecture (K1, K2)
5.6 IEEE 802.11 architecture (K1, K2)

Books for Study:

1. George Kennedy, Brendan Davis, SRM Prasanna, Electronic Communication Systems, McGraw Hill (India) Pvt. Ltd., Fifth Edition, 2011.
2. Simon O. Haykin, Michael Moher,Modern Wireless Communications, Pearson Education, 2007.

Books for Reference:

1. Theodre S. Rappaport, Wireless Communications: Principles and Practice, Pearson Education India, 2009.
2. Gordon L. Stuber, Principles of Mobile Communications, Springer International Ltd., 2001.
3. William Stallings - Wireless Communications and Networks –Pearson Education, Asia, 2002.
4. Robert J. Schoenbeck - Electronic Communications, Modulation and Transmission - Prentice Hall of India, 1999.
5. P. Gnanasivam - Telecommunication Switching and Networks - Prentice Hall of India, 2004

SEMESTER I

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

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

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.Murugeshan&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	Credits	Marks
					6	5	100

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 – Addision 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 Esatern, 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

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 incylindrical 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 betweenparallel 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 avector 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 **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 andradiated 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, radiatedpower (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 II

PCPHF20 - QUANTUM MECHANICS - I

Year: I **Sem:** II	**Course Code:** PCPHF20	**Title of the Course:** Quantum Mechanics – I	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 4	**Marks** 100

Course Objectives

1. To make the students understand the inadequacy of Classical mechanics, the origin of Quantum mechanics and its operators.
2. To impart knowledge about the postulates of Quantum mechanics, its applications and various approximation methods.

Course Outcomes (CO)

The learners will be able to

1. Understand the concepts of Quantum Mechanics.
2. Apply the concept of Quantum mechanics to various problems.
3. Understand various representations in Quantum Mechanics.
4. Attain knowledge about various approximation methods and their applications.
5. Acquire knowledge about Angular momentum and commutation rules.

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

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

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Basic Formalism (14 Hours)

1.1 Limitations of Classical Physics - Wave function for a free particle - Physical significance of wave function - Linear operator –Defns. of Eigen functions and Eigen values (K1,K2)
1.2 Hermitian operator - Theorem on Hermitian operator - Derivation of operators for momentum and total energy - Postulates of Quantum mechanics (K2,K3)
1.3 Time dependent and time independent Schrodinger equations (K3, K4)
1.4 Derivation of Expectation Value of a normalized wave function - Ehrenfest's Theorem(K3, K4, K5)
1.5 Definition of orthonormality - Schrödinger equation in spherical polar coordinates(K3, K4, K5)
1.6 Operator and Eigen values of Orbital angular momentum (K4,K5)

Unit II: Applications (16 Hours)

2.1 Linear harmonic oscillator (Schrödinger method) - Zero point energy (K2, K3, K4, K5)
2.2 Ladder operator - Particle in a Spherically symmetric potential (K2, K3, K4, K5)
2.3 System of two interacting particles - Rigid rotator in three dimensions (K2, K3, K4, K5)
2.4 Problem of Hydrogen atom (K2, K3, K4, K5)
2.5 Particle in a Spherical well(K2, K3, K4, K5)
2.6 Three dimensional Square well potential - The Deuteron (K2, K3, K4, K5)

Unit III: General Formalism (14 Hours)

3.1 Dirac's notation and Hilbert space –Types of equations of motion - Schrödinger representation (K2, K3, K4)
3.2 Heisenberg representation - Interaction representation (K3, K4)
3.3 Definition of Momentum representation - Probability density in momentum representation Operator for position coordinate (K2, K3, K4)
3.4 Operator for momentum - Equation of motion in momentum representation (K3, K4, K5)
3.5 Definition of Unitary transformation - Symmetry transformation - Translation in Space - Conservation of linear momentum Translation in time: Conservation of energy (K2, K3, K4)
3.6 Rotation in space: Conservation of Angular momentum - Space inversion-:Parity conservation (K2, K3, K4)

Unit IV: Angular Momentum (14 Hours)

4.1 Orbital angular momentum operators - Derivation of Orbital angular momentum Commutation relations (K2, K5)
4.2 Total angular momentum J - Eigen values of J^2 and J_Z - Matrix representation of J^2 and J_Z (K2, K3, K4)
4.3 Matrices for J_+, J_-, J_x and J_y-Construction of total angular momentum matrices for different values of j (K4, K5)
4.4 Spin angular momentum - Pauli's spin matrices - Spin vectors for spin half systems Symmetric and anti-symmetric wave functions (K2, K4,)
4.5 Addition of two angular momenta –Clebsch–Gordan coefficients - Selection rules – Procedure for Computation of CG coefficients (K2, K4, K5)
4.6 Computation of CG Coefficients for different values of j_1 and j_2(K6)

Unit V: Approximation Methods **(14 Hours)**

5.1 Time-independent perturbation theory - Derivation of first order, second order perturbation equations - Definition of degeneracy (K2, K4)
5.2 Non degenerate energy levels - First order correction to energy and wave function - Second order correction to energy and wave function (K3, K4)
5.3 Applications - Ground state of anharmonic oscillator - Effect of electric field on the ground state of Hydrogen: Stark effect (K3, K4, K5)
5.4 Degenerate energy levels - First order correction - Variational method principle - Application to ground state of Helium atom (K3, K4, K5)
5.5 WKB Approximation - General solution - Validity of WKB approximation - Classical turning point - Connection formula (K2, K4)
5.6 Bound states in a potential well (WKB quantization rule)- Application to Simple harmonic oscillator (K3, K4, K5)

Books for Study:

1. G. Aruldhas - Quantum Mechanics - Second edition - PHI Learning private Limited, Delhi, 2009.
2. Gupta &Kumar -Quantum Mechanics - 33rd edition -Jai Prakash Nath Publications, 2015.
3. Satyaprakash - Quantum Mechanics - Kedar Nath Ram Nath Publications , 2019
4. V. Devanathan - Quantum Mechanics - Narosa Publishing House, New Delhi, 2005.
5. V.Devanathan- Angular momentum techniques in Quantum Mechanics - Springer publications, 2010.
6. V.K. Thankappan - Quantum Mechanics, 2nd Edition - Wiley Eastern Ltd., New Delhi, 1985.
7. David Bohm - Quantum theory - Courier Corporation, 1989.

Books for Reference:

1. P.M. Mathews and K. Venkatesan - A Textbook of Quantum Mechanics - Tata McGraw Hill, New Delhi, 1976.
2. L.I. Schiff - Quantum Mechanics, 3rd Edition - International Student Edition, McGraw Hill, Kogakusha, Tokyo, 1968.
3. E. Merzbacher - Quantum Mechanics, 2nd Edition - John Wiley and Sons, New York, 1970.
4. P.A.M. Dirac - The Principles of Quantum Mechanics - Oxford University Press, London, 1973.

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

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-Cdiagram(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 ofgood design - Different research design - Basic principles of experimentaldesigns - 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 StatisticalTechniques
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 Sorgi - Research Ed Norosa Publishing House, New Delhi - 2000
3. Robert Ross - Research: An introduction - - Harper and RowPublications.
4. P. Saravanavel - Research methodology - - KitlabMahal, SixthEdition.
5. R.A. Day - How to write and publish a scientific paper – CambridgeUniversity press
6. Anderson - Thesis and Assignment writing - - Wiley EasternLtd.

SEMESTER II

PEPHD20 - ELECTIVE II B: ELECTRONIC INSTRUMENTATION

Year: I **Sem:** II	**Course Code:** PEPHD20	**Title of the Course:** Elective II B: Electronic Instrumentation	**Course Type:** Theory	**Course Category:** Major Elective	**H/W** 4	**Credits** 4	**Marks** 100

Course Objectives

1. To gain knowledge about electronic equipments.
2. To give to the students an application oriented paper.

Course Outcomes (CO)

The learners will be able to

1. Describe the Principle and working of Transistor, Thyristor and other electronic equipments used to measure the physical parameters such as Temperature, pressure and force etc., ,
2. Attain the knowledge of working principle of digital instruments (digital pH meter, digital storage oscilloscope, digital multimeter etc.,)
3. Demonstrate about the description of analytical Instruments (UV-VIS Spectrometer, IR Spectrometer, Flame Emission Spectrometer and ICP-AES Spectrometer) which was used to characterize the materials and analyze the results.
4. Impart the knowledge in working of Bio medical instruments and its applicable to find out any defects in our human body and to save our life.
5. Understand about the essential partsof the computer and their need anddevelop the skills to handle above all instruments useful for our carrier.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	L	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	M	H	H	M
CO4	H	M	L	H	H	M
CO5	H	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	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: Transducers (10 Hours)

1.1 Classification of Transducers- Principle, Construction and working of Thermistor (K1, K2)
1.2 LVDT, Electrical strain gauges (K1, K2, K3)
1.3 and capacitive transducers (K1, K2, K3)
1.4 Measurement of non-electrical quantities (K1, K2, K3, K4)
1.5 Strain, Displacement - Temperature (K1, K2, K3)
1.6 Pressure and Force (K2, K3, K4)

Unit II: Digital Instrumentation (8Hours)

2.1 Principle, block diagram and working of Digital frequency counter (K1, K2, K3)
2.2 Digital multimeter(K1, K2, K3)
2.3 Digital pH meter (K1, K2, K3)
2.4 Digital conductivity meter (K2, K3)
2.5 Digital storage oscilloscope (K1, K2, K3)
2.6 Digital voltmeter (K2, K3, K4)

Unit III: Analytical Instrumentation (10 Hours)

3.1 Principle, block diagram, description, working and applications of UV-VIS Spectrometer (K1, K2, K3)
3.2 IR Spectrometer (K2, K3)
3.3 Flame Emission Spectrometer (K2, K3, K4)
3.4 and ICP-AES Spectrometer (K2, K3, K4)
3.5 Basic concepts of Gas and Liquid Chromatography (K3, K4)
3.6 Elemental analyzers- salt analyzers- CHN analyzers- Thermal analyzers(K3, K4)

Unit IV: Bio-Medical Instrumentation (10 Hours)

4.1 Physiological transducers to measure blood pressure, body temperature (K1, K2)
4.2 Sources of Bio-electric potentials - resting potential (K1, K2, K3)
4.3 action potential, Bio-potential electrodes (K1, K2)
4.4 Principle, block diagram and operation of ECG and EEG - Recorders (K1, K2, K3)
4.5 EMG and - ERG recorders (K3, K4, K4)
4.6 Lead system and recording methods - Typical waveforms - Electrical safety in medical environment - Shock hazards (K1, K2, K3)

Unit V: Computer Peripherals (10 Hours)

5.1 Printers - Printer mechanism - Classification (K1, K2)
5.2 Dot matrix, Ink-Jet and Laser Printers (K1, K2)
5.3 Basic concepts of key board and mouse - Mass storage - floppy disk - Hard Disk - Optical disk (CD) (K1, K2, K3)
5.4 Digital camera - video camera - microphone (K2, K3, K4)
5.5 External hard drives - media card readers - digital camcorders (K1, K2, K3)
5.6 Monitor - projector - TV screen - plotter - speakers (K2, K3, K4)

Books for Study:

1. Dr. Rajendra Prasad - Electronic Measurements and Instrumentation - Khanna Publications,2012.
2. S. Ramambhadran- Elements of Electronic Measurements and Instruments - Khanna Publications,1999.

Books for Reference:

1. S.M. Dhir - Applied Electronics and Instrumentation - Khanna Publishers,1999.
2. Khandpur - Handbook of Biomedical Instrumentation - McGraw Hill Publications, 2014.
3. Theodre S. Rappaport, Wireless Communications: Principles and Practice, Pearson Education India, 2009.
4. William Stallings - Wireless Communications and Networks –Pearson Education, Asia, 2002.

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

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

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 long 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 I & II

PCPHG20 - PRACTICAL - I: GENERAL EXPERIMENTS

Year: I **Sem:** I & II	**Course Code:** PCPHG20	**Title of the Course:** Practical I: General Experiments	**Course Type:** Practical	**Course Category:** Core	**H/W** 3	**Credits** 4	**Marks** 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 **Sem:** I & II	**Course Code:** PCPHH20	**Title of the Course:** Electronics Lab	**Course Type:** Lab	**Course Category:** Core	**H/W** 3	**Credits** 4	**Marks** 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 III

PCPHI20- SPECTROSCOPY

Year: II **Sem:** III	**Course Code:** PCPHI20	**Title of the Course:** Spectroscopy	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 4	**Marks** 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 CO_2 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

PCPHJ20 - QUANTUM MECHANICS - II

Year: II **Sem:** III	**Course Code:** PCPHJ20	**Title of the Course:** Quantum Mechanics - II	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 4	**Marks** 100

Course Objectives

1. To impart knowledge about various theories related to Quantum Mechanics.
2. To understand the importance of relativistic equations.
3. To impart knowledge about Quantization of fields.

Course Outcomes (CO)

The learners will be able to

1. Understand the concept of scattering theory.
2. Achieve knowledge about Perturbation theory.
3. Attain Knowledge about relativistic Quantum Mechanics.
4. Assimilate the concepts of Dirac equation and its applications.
5. Gain knowledge about Quantization of fields.

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

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

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Time dependent Perturbation Theory (14 Hours)

1.1 Time dependent perturbation theory - Constant perturbation (First order perturbation) (K2, K4)
1.2 Harmonic perturbation: Transition to a discrete state - Transition to a continuum states (Fermi's Golden rule) (K3, K4, K5)
1.3 Absorption and emission of radiation: The electromagnetic field - The Hamiltonian operator - Electric dipole approximation (K2, K3, K4)
1.4 Transition probability - Einstein's A and B coefficients (K4, K5)
1.5 Selection rules for dipole transition - Identification of allowed transitions (K2, K4)
1.6 Raman scattering - Rayleigh scattering (K2, K4, K5)

Unit II: Scattering Theory (16 Hours)

2.1 Introduction - Scattering cross section - Scattering amplitude - Relationship between scattering amplitude and differential scattering cross section (K1, K2, K3)
2.2 Partial waves - Partial wave analysis: Scattering by a Central potential - Ramsaur-Townsend effect (K2, K4)
2.3 Optical theorem - Scattering by an attractive square well potential (K2, K3, K4)
2.4 Low energy scattering by an attractive square well potential (Breit Wigner formula)- Scattering length (K2, K4, K5)
2.5 Expression for Phase shifts - Born approximation - validity of Born approximation (K3, K4, K5)
2.6 Scattering by Screened coulomb potential - Scattering in Laboratory and centre of mass co-ordinate systems - Relationship between the cross sections and kinetic energy in centre of mass and laboratory systems (K2, K4, K5)

Unit III: Relativistic Quantum Mechanics (14 Hours)

3.1 Klein-Gordon equation - Interpretation of Klein-Gordon equation (K2, K3, K4)
3.2 Particle in a coulomb field (K3, K4)
3.3 Dirac's equation for a free particle - Dirac matrices - Traces (K2, K4)
3.4 Covariant form of Dirac equation - Probability density (K4, K5)
3.5 Spin of the Dirac particle (electron) (K3, K4, K5)
3.6 Magnetic moment of an electron due to spin (K3, K4, K5)

Unit IV: Dirac Equation (14 Hours)

4.1 Spin orbit interaction (K4, K5)
4.2 Radial equation for an electron in a central potential (K3, K4)
4.3 Hydrogen atom problem - Lamb shift (K2, K3, K4, K5)
4.4 4.4Invariance of Dirac equation under Lorentz transformation - Density matrix - Spin density matrix (K2, K4)
4.5 T-Transformation for the Dirac equation in the presence of electromagnetic field (K3, K4)
4.6 Magnetic resonance - Projection operators for energy and spin (K2, K3, K4)

Unit V: Quantization of Fields **(14 Hours)**

5.1 Second quantization - Concepts of Classical mechanics - Coordinates of a field (K1, K2, K3)
5.2 Classical field equation in Lagrangian form - Classical field equation in Hamiltonian form(K2, K3)
5.3 Quantization of Schrödinger equation - Creation and annihilation operators (K2, K4, K5)
5.4 Relativistic fields - Natural units - Quantization of Klein-Gordon field (K2, K4, K5)
5.5 Quantization of Dirac field (K4, K5)
5.6 Quantization of electromagnetic field (K4, K5)

Books for Study:

1. G. Aruldhas - Quantum Mechanics - Second edition - PHI learning private Limited, Delhi, 2009.
2. Gupta & Kumar - Quantum Mechanics - 33rd edition -Jai Prakash Nath Publications-2015.
3. Satyaprakash - Quantum Mechanics - Kedar Nath Ram Nath Publications - 2019
4. V. Devanathan - Quantum Mechanics - Narosa Publishing House, New Delhi, 2005.
5. V.K. Thankappan - Quantum Mechanics, 2nd Edition - Wiley Eastern Ltd., New Delhi, 1985.
6. B.K.Agarwal- Quantum Mechanics and Field theory - LokbharatiPrakashan publications, 2003.

Books for Reference:

1. P.M. Mathews and K. Venkatesan - A Textbook of Quantum Mechanics - Tata McGraw Hill, New Delhi, 1976.
2. L.I. Schiff - Quantum Mechanics, 3rd Edition - International Student Edition, McGraw Hill, Kogakusha, Tokyo, 1968.
3. E. Merzbacher - Quantum Mechanics, 2nd Edition - John Wiley and Sons, New York, 1970.
4. P.A.M. Dirac - The Principles of Quantum Mechanics - Oxford University Press, London, 1973.

SEMESTER III

PCPHK20 – MICROPROCESSORAND 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

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

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

PEPHF20 - ELECTIVE - III B: ADVANCED OPTICS

Year: II Sem: III	Course Code: PEPHF20	Title of the Course: Advanced Optics	Course Type: Theory	Course Category: Core Elective	H/W	Credits	Marks
					4	4	100

Course Objectives

1. To provide the knowledge on optics for higher studies.

Course Outcomes (CO)

The learners will be able to

1. Understand the basic concepts of Laser theory
2. Understand and describe the different types of Laser
3. Explain the propagation of Laser beam
4. Describe the principle, types and loss of optical fiber
5. Understand the importance of nonlinear optics and apply the concepts of NLO to optical materials.

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

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

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Basic Laser theory (9 Hours)

1.1 Historical background of laser (K1, K2)
1.2 Einstein coefficients and (K1, K2, K3)
1.3 Stimulated light amplification (K1, K2)
1.4 Population inversion (K1, K2)
1.5 Creation of population inversion in three level and four level lasers (K3, K4)
1.6 Applications (K4, K5)

Unit II: Basic laser systems (10 Hours)

2.1 Gas Lasers - CO_2 laser - N2 Laser (K1, K2, K3)
2.2 Helium Neon - Argon , Krypton, and Xenon ion lasers (K1, K2, K3)
2.3 Solid state laser - Nd:YAG Laser (K2, K3, K4)
2.4 Semiconductor laser - Ruby Laser (K2, K3, K4)
2.5 Liquid laser - Europium Chelate (K2, K3, K5)
2.6 Dye Laser - Courmarin dye laser (K2, K3, K4)

Unit III: Laser Beam Propagation (9 Hours)

3.1 Laser beam propagation - properties of Gaussian beam (K1, K2, K3)
3.2 Resonator - stability - various types of stability (K2, K3, K4)
3.3 Resonator for high gain and high energy lasers (K2, K3, K4)
3.4 Gaussian beam focusing - Properties of Laser Radiation (K1, K2, K3)
3.5 Mode Locking Lasers - Basic principle - Techniques (K1, K2, K3)
3.6 Q Switching - Pulse Shaping (K2, K3, K4)

Unit IV: Fiber optics (10 Hours)

4.1 Optical fiber waveguides principles - acceptance angle - Total internal Reflection - Numerical aperture (K1, K2, K3)
4.2 types of fibers- step index - graded index - single mode - multi mode - step index multi-modefiber - graded index multi-modefiber(K1, K2, K3)
4.3 attenuation in fiber- Losses in fiber- fiber bandwidth - Fiber alignment and joint loss (K2, K3, K4)
4.4 Fabrication of optical fiber- Liquid Phase- Vapour phase deposition - Chemical vapour deposition (K2, K3, K4)
4.5 Fiber splices - Mechanical splices - Fiber connectors: cylindrical ferrule expanded beam connectors (K3, K4, K5)
4.6 Fiber couplers: Three and four port couplers - star couplers (K3, K4, K5)

Unit V: Non-linear optics (10 Hours)

5.1 Introduction - origin of non-linearity (K1, K2, K3)
5.2 Susceptibility tensor - phase matching - second harmonic generation (K1, K2, K3)
5.3 Kurtz powder method of finding SHG - Z-scan technique (K1, K2, K3)
5.4 Intensity dependent refractive index - self-focusing - Phase matching –four wave mixing (K1, K3) - frequency mixing processes (K2, K3, K4)
5.5 Nonlinear Schrödinger equation for solitons - soliton switching - soliton laser- advantages of soliton based communication (K3, K4, K5)

5.6 Applications of Non-linear optical materials (K3, K4, K5)

Book for study:

1. Murugeshan and KiruthigaSivarprasath- Modern Physics , 17th Revised Edition- S.Chand&Co.Pvt Ltd., New Delhi,2017
2. K. Thyagarajan, and A.K. Ghatak - Laser Theory and Applications –MacmillanIndia Ltd,1997.
3. B.B. Laud - Lasers and Non Linear Optics - Wiley Eastern Ltd.,1991.
4. R.L. Sautherland- Handbook of Non LinearOptics

Books for Reference:

1. AjoyGhatakandK.Thyagaran- IntroductiontoFiberOptics- CambridgeUniversity Press, 6thEd.,2006.
2. K.R. Nambiar - Laser Principles, Types and Applications - New Age International, 2004.

3.Robert W Boyd - Non linearFiber Optics, 2nd Ed., Elsevier,2006.

SEMESTER III

PIPHE20 - IEP: PHYSICS FOR SET/NET-PAPER III

Year: II **Sem:** III	**Course Code:** PIPHE20	**Title of the Course:** IEP: Physics for SET/NET - Paper III	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**Credits** 2	**Marks** 100

Course Objectives

1. To impart knowledge about Quantum Mechanics, Atomic & Molecular Physics and Spectroscopy for competitive Examination.

Course Learning Outcomes (CO)

The learners will be able to

1. Understand about Schrödinger equation, ladder operators and the concepts of time independent theory to solve Eigen value problems
2. Describe the properties of relativistic quantum mechanics and solve the problems using Fermi's Gold rule.
3. Understand the energy levels and structure of hydrogen atom and to solve the problems using ESR, NMR and Frank-Condon Principle.
4. Attain the basic concepts and theories in basic elements of atomic and molecular spectroscopy, classical/Quantum description of electronic, vibrational and rotational spectra and solve the problem related to that.
5. Gain the knowledge to solve the problems by using the theory of Raman, NMR and Spin resonance spectroscopy in order to face competitive exams and for perusing higher research work.

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

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

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Quantum Mechanics I

1.1 Wave- particle duality - Schrodinger Equation - Time dependent and Time independent(K1, K2, K3)
1.2 Expectation value - Uncertainty principle - Ladder operators (K1, K2, K3)
1.3 Eigen value problems particle in a box - Harmonic oscillator (K2, K3, K4)
1.4 Spherical well - Tunneling through a barrier - Hydrogen atom, Coordinate and Momentum representations (K2, K3, K4)
1.5 1.5Approximation methods - Time independent perturbation theory - Hydrogen variation method (K3, K4, K5, K6)
1.6 WKB method. Angular momentum operators - CG coefficients - Pauli's spin matrices (K3, K4, K5, K6)

Unit II: Quantum Mechanics II

2.1 Scattering theory - Scattering amplitude - Cross sections (K1, K2)
2.2 Partial wave analysis - Effective range theory - Optical theorem (K1, K2, K3)
2.3 Time dependent perturbation theory - Transition probabilities - Fermi's Golden rule and selection rules for dipole radiations (K1, K2, K3, K4)
2.4 Klein-Gordan equation - Dirac equation (K3, K4, K5)
2.5 Plane wave solution - Negative energy states - Antiparticles - Properties of Gamma matrices (K3, K4, K5, K6)
2.6 Quantization of fields - Semi classical theory of radiation - Creation - Destruction and Number operators (K3, K4, K5)

Unit III: Atomic and Molecular Physics –I

3.1 Quantum states of an electron in an atom - Electron spin (K1, K2)
3.2 Spectrum of helium and alkali atom. –Relativistic corrections for energy levels of hydrogen atom (K1, K2, K3)
3.3 Hyperfine structure and isotopic shift - Width of spectrum lines - (K1, K2, K3, K4)
3.4 LS & JJ couplings - Zeeman, Paschen - Bach & Stark effects (K2, K3, K4)
3.5 Electron spin resonance - Nuclear magnetic resonance - (K3, K4, K5)
3.6 Chemical shift - Frank-Condon principle (K4, K5)

Unit IV: Atomic and Molecular Physics –II

4.1 Born-Oppenheimer approximation (K1, K2)
4.2 Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules (K1, K2, K3)
4.3 Lasers: spontaneous and stimulated emission (K2, K3, K4)
4.4 Einstein A & B coefficients. Optical pumping (K3, K4)
4.5 Population Inversion - Rate equation (K2, K3, K4)
4.6 Modes of resonators and Coherence length (K2, K3, K4, K5)

Unit V: Spectroscopy

5.1 Rotational spectra of diatomic - Polyatomic and symmetric top molecules (K1, K2, K3)
5.2 IR of diatomic and simple polyatomic molecules - Harmonic/anharmonic oscillator (K2, K3)

5.3 Normal modes of vibrations - Raman scattering - Raman Effect in inorganic - Organic and physical chemistry (K1, K2)
5.4 NMR - chemical shift - Single coil and double coil methods (K2, K3, K4)
5.5 NQR - Nuclear quadrupole energy levels for axial/non-axial symmetry (K2, K3, K4)
5.6 ESR - Nuclear interaction and hyperfine structure. Mossbauer Effect - Hyperfine/electric quadrupole interactions (K3, K4, K5)

Book for study:

1. G. Aruldhas - Quantum mechanics, PHI Learning,2008.
2. Gupta Kumar Sharma - Quantum Mechanics Jai Prakash Nath Publications,2012.
3. Devanathan- QuantumMechanics
4. B.K. Sharma - Spectroscopy - Goel publishing House Krishna PrakashanMediaPvt., Ltd.,2017.

Book for Reference:

1. Mathews Venkatesan - Quantum Mechanics
2. C.N. Banwell and E.M. Mc Cash - Fundamentals of Molecular Spectroscopy,Tata McGraw Hill Publications, Reprint2017.
3. G. Aruldas- Molecular structure and Spectroscopy, Prentice Hall of IndiaPvt., Ltd., New Delhi, 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

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

PCPHL20 - MATERIALS SCIENCE AND LASER PHYSICS

Year: II **Sem:** IV	**Course Code:** PCPHL20	**Title of the Course:** Materials Science and Laser Physics	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 5	**Marks** 100

Course Objectives

1. To impart knowledge about phase diagram and defects in crystals
2. To acquire knowledge about polymer and ceramics
3. To understand the principle and working of lasers

Course Outcomes (CO)

The learners will be able to

1. To acquire knowledge about phase diagrams
2. To Impart knowledge about defects in crystals
3. Learn the basic principles of optical, Dielectric and Ferro Electric properties of materials
4. To acquire knowledge about polymer and ceramics
5. To understand the principle and working of Lasers

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	L	L	M	L	L
CO2	H	M	M	H	H	M
CO3	M	L	M	M	H	M
CO4	H	L	M	M	M	M
CO5	H	M	L	H	M	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: Phase Diagram & Defects **(15 Hours)**

1.1 Phase diagram - Basic principles - Simple binary systems - Solid solutions (K1, K2, K3)
1.2 Eutectic systems- Application - Interstitial and substitution solid solutions (K1, K2)
1.3 Elementary Ideas of corrosion - Oxidation - Creep and fracture (K4, K5)
1.4 Dislocations- Edge and screw dislocations - Stress fields around dislocations - Density - Work hardening (K1, K2, K4)
1.5 Plastic deformation - Slip - Motion of dislocations under uniform Shear Stress (K3, K4, K5)
1.6 Effect of grain size on dislocation motion –Effect of solute atoms on dislocation motion (K3, K4)

Unit II: Optical Properties **(13 Hours)**

2.1 Atomic and Electromagnetic Radiation - Light Interactions with Solids (K1, K2, K3)
2.2 Electronic Interactions (K1, K2)
2.3 Refraction - Reflection - Absorption - Transmission (K1, K2, K3)
2.4 Colourcenters- Photo conductivity - Electronic transitions in Photo conductors (K1, K2)
2.5 Trap, capture, recombination centers- Luminescence (K1, K2, K3)
2.6 Excitation and emission Decay mechanisms -(K1, K2, K4)

Unit III: Magnetic Properties **(14 Hours)**

3.1 Diamagnetism and Paramagnetism(K1, K2)
3.2 Ferromagnetism - Antiferromagnetism and Ferrimagnetism (K1, K2)
3.3 Thallium activated alkali halides - Sulfide phosphorous - Ferroelectrics (K2, K3, K4)
3.4 Ferro electricity - General properties - Dipole theory (K1, K2)
3.5 Ionic displacements and the behaviour of BaTiO3 - Spontaneous polarization of $BaTiO_3$(K3, K4, K5)
3.6 Thermodynamics of Ferro electric transitions (K1, K2)

Unit IV: Elastic Behaviour, Polymer and Ceramics **(14 Hours)**

4.1 An elastic and visco elastic behaviour - Atomic model of elastic behaviour (K1, K2)
4.2 Rubber like elasticity - An elastic deformation - Relaxation process (K2, K3, K4)
4.3 Model for visco elastic behaviour - Polymers - Polymerization mechanism (K1, K2)
4.4 Polymer structures - Deformation of polymers - Behaviour of polymers (K1, K2, K4)
4.5 Ceramics - Ceramic phases - Structure - classes (K1, K2)
4.6 Effect of structure on the behaviour of ceramic phases - composites and its basic properties (K3, K4, K5)

Unit V: Laser Physics **(16 Hours)**

5.1 Introduction - Interaction of radiation with matter - Spontaneous and stimulated emission (K1, K2)
5.2 Conditions for oscillation to occur - Frequency of oscillation of the system (K1, K2, K4)
5.3 Einstein co-efficient - Population inversion - Laser pumping Rate equations (K1, K2)
5.4 Three level laser - Four level Laser - Nd:YAG Laser - He-Ne Laser - Optical resonator (K3, K4, K5)

5.5 Types and modes of resonator - Oscillation - Threshold condition - The confocal resonant cavity (K1, K2)

5.6 Theory - Spot size and beam divergence - quality factor (Q) of an optical cavity (K2, K3, K4)

Books for Study:

1. G.K. Narula, K.S. Narula and V.K. Gupta - Material Science, TMH, New Delhi, 1995.
2. A.J. Dekker - Solid State Physics - McMillan Co., 1981.
3. V.Ragavan - Material Science and Engineering, 4th Edition - Prentice Hall of India, New Delhi, 2003.
4. M. Arumugam - Materials Science, 3rd Edition - Anuradha Agencies, 2002.

Books for Reference:

1. Lawrence H. Vlack - Elements of Materials Science and Engineering, 6th Edition -Reprint, Addison-Wesley, 1998.
2. H. Iabch and H. Luth - Solid State Physics: An introduction to Principles of Material Science, 2nd Edition, Springer, 2001.
3. B.B. Laud - Lasers and Non linear optics, Wiley Eastern Ltd, 1991.
4. Verdayan J.J. - Laser Electronics - Prentice-Hall India, New Delhi, 1993.
5. Allen and Jones - Principles of Gas Lasers - Butterworths, London, 1967.
6. K.R. Nambiar - Laser Principles, Types and Application - New Age International, 2004.
7. K. Thyagarajan and A.K. Ghatak - Laser Theory and Applications - Macmillan India Ltd., 1997.

SEMESTER IV

PCPHM20- NUCLEAR AND PARTICLE PHYSICS

Year: II **Sem:** IV	**Course Code:** PCPHM20	**Title of the Course:** Nuclear And Particle Physics	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 4	**Marks** 100

Course Objectives

1. To impart knowledge about nuclear- interactions, reactions, models and basic concepts in elementary particles.

Course Outcomes (CO)

The learners will be able to

1. Apply core concepts in physics to understand nuclear interactions, features of nuclear reactions and characteristics of radioactive decays (beta & gamma).
2. Describe basic nuclear structure and nuclear properties by applying the mathematical theory and models (liquid drop model, Shell model, collective model, optical model etc.)
3. Evaluate some basic nuclear parameters such as radius, BE, Q-value, nuclear spin, parity etc.
4. Classify elementary particles (based on interactions and spin) and explain the fundamental concepts in particle physics (conservation laws, parity violation, interactions etc.)
5. Study the substructure and symmetries in elementary particles (SU (2) &SU (3)); apply Quark model to find the missing particle.

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

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

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Nuclear Interactions **(14 Hours)**

1.1 Introduction - Nuclear forces - Two body problem (K1, K2)
1.2 Ground state of deuteron - Magnetic moment - Quadrupole moment - Tensor forces (K2, K3, K4)
1.3 Meson theory of nuclear forces - Yukawa potential (K3, K4)
1.4 Nucleon - Nucleon scattering - Low energy n-p scattering (K2, K3, K4)
1.5 Effective range theory - Spin dependence (K3, K4)
1.6 Charge independence and charge symmetry of nuclear forces-Isospin formalism (K3, K4)

Unit II: Nuclear Reactions **(15 Hours)**

2.1 Types of reactions and conservation laws (K1, K2)
2.2 Energetic of nuclear reactions –Dynamics of nuclear reactions - Q-value equation (K2, K3, K4, K5)
2.3 Scattering and reaction cross sections (K3, K4, K5)
2.4 Compound nucleus reactions -Scattering matrix - Reciprocity theorem (K2, K3, K4)
2.5 Breit - Wigner one level formula - Resonance scattering (K2, K3, K4)
2.6 Continuum theory - Optical model (K3, K4)

Unit III: Nuclear Models **(13 Hours)**

3.1 Introduction - Liquid drop model (K2, K3, K4)
3.2 Semi empirical mass formula of Weizsacker- Nuclear stability- Mass parabolas (K3, K4, K5)
3.3 Bohr-Wheeler theory of fission (K3, K4, K5)
3.4 Shell model - Spin-orbit coupling - Magic numbers (K3, K4)
3.5 Angular momenta and parities of nuclear ground states (K4, K5)
3.6 Collective model of Bohr and Mottelson-Nilsson Model - Oblate and prolate deformations of Nucleus (K3, K4)

Unit IV: Nuclear Decay **(15 Hours)**

4.1 Beta decay - Fermi theory of beta decay - Fermi - Curie Plot (K3, K4, K5)
4.2 Fermi and Gamow- Tellar selection rules - Allowed and forbidden decays - Decay rates (K4, K5)
4.3 Theory of neutrino - Helicity of neutrino (K2, K4)
4.4 Theory of electron capture - Non conservation of parity (K3, K4)
4.5 Gamma decay - Multipole transitions in nuclei (K3, K4)
4.6 Internal conversion - Nuclear isomerism (K3, K4)

Unit V: Elementary Particle Physics **(15 Hours)**

5.1 Types of interaction between elementary particles - Hadrons and leptons (K2, K4)
5.2 Quantum numbers and conservation laws (K2)
5.3 Symmetries - Elementary ideas of CP and CPT invariance (K2, K4)
5.4 Classification of hadrons - SU(2) and SU(3) multiplets (K3, K4, K5)
5.5 Quark model - Gell-Mann-Okubo mass formula for octet and decupled hadrons (K3, K4, K5)
5.6 Charm, bottom and top quarks (K2)

Books for Study:

1. M.L. Pandya and R.P.S. Yadav - Elements of Nuclear Physics, 7th Edition, KedarNath Ram Nath, Delhi, 1995.
2. D.C.Tayal- Nuclear Physics - Himalaya Publishing House, 2006.
3. S.N. Ghoshal - Atomic and Nuclear Physics, Vol. 2 - S Chand & Co. Ltd., 2000.
4. V.Devanathan- Nuclear Physics, 2nd Edition - Narosa Publication, 2011.

Books for Reference:

1. K. S. Krane - Introductory Nuclear Physics - Wiley, New York, 1987.
2. D. Griffiths - Introduction to Elementary Particle Physics - Harper & Row, New York, 1987.
3. R. R. Roy and B.P. Nigam - Nuclear Physics - New age Intl. New Delhi, 1983.
4. H. A. Enge - Introduction to Nuclear Physics - Addison-Wesley, Tokyo, 1983.
5. Y. R. Waghmare - Introductory Nuclear Physics - Oxford-IBH, New Delhi, 1981.
6. J. M. Longo - Elementary particles, McGraw Hill, New York, 1971.
7. R. D. Evans - Atomic Nucleus - McGraw Hill, New York, 1955.
8. Kaplan - Nuclear Physics - Narosa, New Delhi, 1989.
9. B. L. Cohen - Concepts of Nuclear Physics - TMH, New Delhi, 1971.
10. M. K. Pal - Theory of Nuclear Structure - Affl. East-West, Chennai, 1982.
11. W. E. Burcham and M. Jobes - Nuclear and Particle Physics - Addison-Wesley, Tokyo, 1995.

SEMESTER IV

PCPHN20 - CONDENSED MATTER PHYSICS

Year: II **Sem:** IV	**Course Code:** PCPHN20	**Title of the Course:** Condensed Matter Physics	**Course Type:** Theory	**Course Category:** Core	**H/W** 6	**Credits** 4	**Marks** 100

Course Objectives

1. To relate crystal structure to symmetry, recognize the correspondence between real and reciprocal space.
2. To know about the theories of metals and semiconductors
3. To develop an understanding of the dielectric properties and ordering of dipoles in ferroelectrics.
4. To get familiarized with the different parameters associated with superconductivity and the theory of superconductivity.

Course Learning Outcomes (CO)

The learners will be able to

1. Able to correlate the X-ray diffraction pattern for a given crystal structure.
2. Formulate the theory of lattice vibrations and use that to determine thermal properties of solids.
3. Ability to understand theory of metals and semiconductors.
4. Able to differentiate between ferroelectric, anti-ferroelectric materials.
5. Able to differentiate between type-I and type-II superconductors and their theories.

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

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

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Crystal Physics **(13 Hours)**

1.1 Types of lattices - Miller indices - Simple crystal structures(K1, K2)
1.2 Crystal diffraction - Bragg's law (K1, K2)
1.3 Reciprocal lattice [Sc,bcc, fcc] - Laue equation (K1, K2, K5)
1.4 Structural factor - Atomic form factor (K1, K2)
1.5 Types of crystal binding - Cohesive energy of ionic crystals (K1, K2)
1.6 Madelung constant - types of crystal bonding (general ideas) (K1, K2)

Unit II: Lattice Dynamics **(14 Hours)**

2.1 Monoatomic lattices - lattices with two atoms per primitive cell (K1, K2)
2.2 First Brillouin zone - group and phase velocities (K1, K2)
2.3 Quantization of lattice vibrations - Phonon momentum (K1, K2, K3)
2.4 Inelastic scattering by phonons - Debye's theory of lattice heat capacity (K1, K2)
2.5 Einstein's model and Debye's model of specific heat (K1, K2, K5)
2.6 Thermal expansion - Thermal conductivity - Umklapp processes (K1, K2)

Unit III: Theory of Metals and Semiconductors **(15 Hours)**

3.1 Free electrons gas in three dimensions - Electronics heat capacity- Wiedmann Franz law (K1, K2, K3)
3.2 Hall effect - Bloch theorem - Kronig-Penny model(K1, K2, K5)
3.3 Band theory of metals and semiconductors (K1, K2)
3.4 Semiconductors - Density of States - Intrinsic and Extrinsic carrier concentration (K1, K2, K3)
3.5 Mobility - Impurity conductivity (K1, K2)
3.6 Fermi surfaces and construction - De Haas Van Alphen effect (K2, K4, K5)

Unit IV: Magnetism **(16 Hours)**

4.1 Elementary ideas of dia, Para and Ferro magnetism - quantum theory of paramagetism (K1, K2, K3)
4.2 Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization Quantum theory of ferromagnetism (K1, K2)
4.3 Curie point Exchange integral - Heisenberg's interpretation of Weiss field (K1, K2, K3)
4.4 Ferromagnetism domains - Bloch Wall - Spin waves quantization - Magnos (K1, K2)
4.5 Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnetisms (K1, K2, K3)
4.6 Theory anti ferromagnetism - Neel temperature (K1, K2)

Unit V: Super Conductivity **(14 Hours)**

5.1 Experimental facts - occurrence - Effect of magnetic fields - Meissner effect (K1, K2)
5.2 Entropy and heat capacity - Energy gap - Microwave and infrared properties (K1, K2, K5)
5.3 Type I and type II Super conductors - Theoretical explanation (K1, K2, K3)
5.4 Thermodynamics of Super conducting transition - London equation - Coherence length (K1, K2)
5.5 Theory - Single particle tunneling- Josephson tunneling (K1, K2)

5.6 DC and AC Josephson's effect - High temperature super conductors - SQUIDS (K1, K2, K4)

Books for Study:

1. S.O Pillai - Solid State Physics, 7th Edition - New Age International, Delhi, 2015.
2. Guptha Kumar - Solid State Physics, 9th Edition - K.Nath& Co. Education, 2006.
3. K.Ilangovan - Solid State Physics - MJP Publications, Chennai, 2013.

Books for Reference:

1. A.J. Dekkar - Solid State Physics - Macmillan India, New Delhi, 2007.
2. H.M. Rosenberg - The Solid State Physics, 3rd Edition - Oxford University, Oxford. 1993.
3. S.L. Altman - Band Theory of Metals: The Elements - Pergamon Press Ltd., Oxford, 1970.
4. J.M. Ziman - Principles of the Theory of Solid - Cambridge University Press, London, 1971.
5. C. Kittel - Introduction to Solid State Physics, 7th Edition - New York, 1996.
6. M.Ali Omar - Elementary Solid State Physics: Principles, Applications - Addison- Wesley, London, 1974.
7. H.P. Myers - Introductory Solid State Physics, 2nd Edition - V K Taylor Francis Ltd., 1998.

SEMESTER IV

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

Year: II **Sem:** IV	**Course Code:** PEPHG20	**Title of the Course:** Fibre Optics and Non-Linear Optics	**Course Type:** Theory	**Course Category:** Major Elective	**H/W** 5	**Credits** 4	**Marks** 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 multi-mode 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.Silvast, Laser fundamentals, Cambridge university press, Cambridge 2003.

Books for Reference:

1. Akira Hasegawa and Yujiodama - 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 **Sem:** IV	**Course Code:** PEPHH20	**Title of the Course:** Advanced Material Science	**Course Type:** Theory	**Course Category:** Major Elective	**H/W** 5	**Credits** 4	**Marks** 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, chi, and Tc (K1, K2)
2.3 Magneto thermal effect - magneto resistance (K1, K2)
2.4 Magneto optical phenomena - magnetic 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 Tc 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, K
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- Introductiontosuperconductivity- RhinehardandWintonNewYork, 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.AliOmar- ElementarySolidStatePhysics-RevisedPrintingPearsonEdn.,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, Philadephia, 1989.

SEMESTER IV

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

Year: II **Sem:** IV	**Course Code:** PIPHG20	**Title of the Course:** IEP: Physics for SET/NET – Paper IV	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**Credits** 2	**Marks** 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 - Macmllan India, New Delhi.

SEMESTER IV

PIPHH20- IEP: ADVANCED NUCLEAR PHYSICS AND SPECTROSCOPY

Year: II **Sem:** IV	**Course Code:** PIPHH20	**Title of the Course:** IEP:Advanced Nuclear	**Course Type:** Theory	**Course Category:** Independent Elective	**H/W** -	**Credits** 2	**Marks** 100

Course Objectives

1. To impart knowledge about nuclear detectors and particle accelerators, basic aspects of astrophysics and applications of nuclear physics.
2. Beside this, students will be familiarized to UV spectroscopy, atomic absorption and emission spectroscopic techniques.

Course Outcomes (CO)

The learners will be able to

1. Explain the basic concepts of nuclear detectors and particle accelerators.
2. Explain the basic aspects of astrophysics.
3. Explain the principles, working and application of nuclear spectroscopic techniques (RBS, NAA, PIXE) and other applications of nuclear physics.
4. Explain the basic principles, instrumentation and applications of UV spectroscopy.
5. Explain the basic principles, instrumentation and applications of atomic absorption and emission spectroscopy.

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

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

(Low - L, Medium – M, High - H)

Course Syllabus

Unit I: Nuclear Detectors and Particle Accelerators

1.1 Introduction - Interaction of radiation with matter (K1, K2)
1.2 Ge and Si solid state detectors - Calorimeters and their use for measuring jet energies (K2, K3)
1.3 Scintillation and Cerenkov counters (K2, K3)
1.4 Qualitative ideas, Hybrid detectors (K2, K3)
1.5 Particle accelerators - Pelletron-Synchrotron - Synchrocyclotron (K2, K3)
1.6 Colliding beam accelerators - Large Hadron Collider (K2, K3)

Unit II: Nuclear Astrophysics

2.1 Cosmic rays: Origin of cosmic rays (K2, K3)
2.2 Nature of primary cosmic rays and its energy distribution (K2, K3)
2.3 Geomagnetic and Latitude effect - East-west asymmetry - Origin of secondary rays (K2, K3)
2.4 Collision with electrons - Thermonuclear fusion (K2, K3)
2.5 Stellar nucleo- synthesis - Energy production in stars (K2, K3)
2.6 PP chain - CNO cycle. (K2, K3)

Unit III: Applications of Nuclear Physics

3.1 Rutherford Backscattering Spectroscopy as a tool for depth profiling (K2, K3, K4)
3.2 Nuclear Fission Reactors (K2, K3)
3.3 Neutron Activation Analysis (K2, K3, K4)
3.4 Proton Induced X-ray Emission for trace element analysis (K2, K3, K4)
3.5 Radioactive dating - Mossbauer Effect (K2, K3)
3.6 Applications in medicine (K3, K4)

Unit IV: UV Spectroscopy

4.1 Energy levels - Molecular orbital's theory and UV spectra (K2, K3)
4.2 Franck Condon Principle - Transition Probability - Measurement of spectrum (K2, K3, K4)
4.3 Types of transition in Organic molecules - Types of absorption bands (K2, K3)
4.4 Transition in metal complexes - Selection rules (K2, K3, K4)
4.5 Electronic spectra in poly atomic molecules - Chromospheres concept (K2, K3)
4.6 Application of UV Spectroscopy (K3, K4)

Unit V: Atomic Absorption and Emission Spectroscopy

5.1 Principle of AAS - Measurement of atomic absorption (K2, K3)
5.2 Instrumentation - Single beam Spectrophotometer (K2, K3)
5.3 Applications of AAS (K2, K3, K4)
5.4 Atomic Emission Spectroscopy - Principle of AES - Advantages (K2, K3)
5.5 Instrumentation - Laser beam - Applications of AES (K2, K3, K4)
5.6 Difference between AAS and AES (K3, K4)

Books for Study:

1. G. Aruldhas - Molecular Structure and Spectroscopy - Prentice Hall of India Pvt. Ltd., New Delhi, 2001.
2. H.Kaur - Spectroscopy, 5th Edition - A PragatiPrakashan, 2009
3. P. S. Sindhu - Molecular Spectroscopy - Tata McGraw Hill, New Delhi, 1990.
4. Krane K.S. Nuclear Physics, Wiley India Pvt. Ltd., (2008).
5. Lilley J.S., Nuclear physics principles and applications John Wiley & sons Ltd., (2007).

Books for Reference:

1. Raymond Chang - Basic Principles of Spectroscopy - McGraw Hill Kogakusha, 1980.
2. G. W. King - Spectroscopy and Molecular Structure - HoitRinchart and WinstenInc, London, 1964
3. Concepts of Modern Physics: A.Beiser.
4. Subatomic Physics, Frauenfelder and Henley. (Prentice-Hall)
5. De Soete, D. R. Gijbelsa n d J. Hoste, Neutron Activation Analysis. John Wiley and Sons: New York, NY. (1972).
6. L. C. Feldmen and j. W. Mayer, fundamentals of surface and thin film s analysis, North Holland, Elsevier, 1986.
7. W. R. Leo, Techniques for Nuclear and Particle Physics Experiments, Narosa Publishing House, Indi, 1995.
8. G. F.Knoll, Radiation Detection and Measurement, John, Wiley & Sons, Inc, 2000.

SEMESTER IV

PCPHO20- PRACTICAL III: ADVANCED GENERAL EXPERIMENTS

Year: II **Sem:** IV	**Course Code:** PCPHO20	**Title of the Course:** Practical III: Advanced General Experiments	**Course Type:** Practical	**Course Category:** Core	**H/W** 4	**Credits** 4	**Marks** 100

Course Objectives

1. To provide the student hands-on experiences to conduct advanced general experiments in laboratory in lieu with the theory taught in the class.

Course Outcomes (CO)

The learners will be able to

1. Interpret and appreciate the advanced concepts in physics.
2. Use scientific equipment for analysis and data acquisition.
3. Analyse the properties (electric, magnetic, nuclear and dielectric) of solids/liquids.
4. Apply acquired knowledge to the analysis of experimental data.
5. Get exposure to work environment at research level and motivation for a lifelong learning.

CLO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CLO1	H	L	H	L	H	H
CLO2	M	H	L	M	H	H
CLO3	H	H	H	M	H	H
CLO4	H	M	H	L	H	H
CLO5	L	M	L	L	H	H

CLO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CLO1	H	H	H	H	H	H
CLO2	H	H	M	M	H	H
CLO3	H	H	H	M	H	H
CLO4	H	M	H	M	H	H
CLO5	H	H	H	H	H	H

(Low - L, Medium – M, High - H)

Course Syllabus

(Any 15 experiments) (K1 - K6)

1. G.M. Counter - characteristics, Inverse square law.
2. G.M. Counter - Absorption co-efficient.
3. Determination of Carrier Concentration - Hall Effect.
4. Determination of Volume Susceptibility of a liquid by Quincke’s method.
5. Determination of Mass Susceptibility of a liquid by Guoy’s method.
6. Michelson Interferometer -Wavelength and separation of wavelengths.
7. Michelson Interferometer - Thickness of mica sheet.
8. F.P. Etalon using Michelson set up.
9. Determination of Wave length of Laser Beam.
10. Ultrasonic Interferometer - Velocity and Compressibility of a liquid.
11. Ultrasonic Diffraction - Velocity and Compressibility of a liquid.
12. Determination of Planck’s constant.
13. B-H curve using CRO.
14. Salt Analysis using Spectrograph - CDS
15. Dielectric constant of liquids and solids by capacitance method.
16. Determination of coefficient of coupling by AC bridge method.
17. Impedance measurement using LCR bridge.
18. Four probe method - Determination of conductivity of thin films.
19. Determination of dielectric loss using CRO.
20. Laser diode characteristics.

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

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.

CourseOutcomes (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.