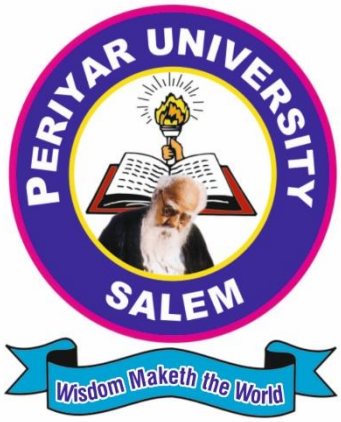
PERIYAR UNIVERSITY
SALEM – 636 011



[Choice Based Credit System (CBCS)]

REGULATIONS AND SYLLABUS

(Effective from the academic year 2025-2026 and thereafter)

CONTENTS

1. Preamble

Department of Physics was established in the year of 2004. From the very inception, the department has been conducting M.Sc. and Ph.D. degree programmes in Physics. The main objectives of the department are to provide high quality teaching and research. This creates knowledge and skill based society to challenge the current and future scientific and technology developments. The designed syllabi facilitate the stakeholders to perceive the wide spectrum of knowledge in Physics and this will make them to pursue research in national laboratories in India and abroad and to hold key positions in scientific and academic arena at various capacities. This syllabi covers to teach several important core areas of Physics and some elective and interdisciplinary subject areas, which allows the stakeholders to broaden their knowledge beyond pure Physics. The subjects being taught in the department includes, Classical Mechanics, Mathematical Physics, Quantum Mechanics and Statistical Mechanics are the mathematical based analytical subjects of Physics and this forms a good platform for learning other subjects in Physics as well as Physical and Chemical Sciences. Apart from that the Electronic subjects, Solid State Physics, Electromagnetic Theory, Spectroscopy, Modern Optics and Computer programming and simulation are some of the core and elective subjects intact in the curriculum. Experiments for the advanced level Electronics and General Physics Practical have designed to enrich the stakeholders to attain experimental understanding and computer simulations.

Creation of new knowledge by doing cutting edge research is the another goal of the department. To accomplish the same, the department involved research in the areas of structural investigation of crystalline materials by X-ray Crystallography, Molecular dynamics simulation and Quantum chemical calculations, Synthesis of new biomaterials, Energy materials, Fabrication of new solar cells, Supercapacitors and Molecular modelling. The research programmes being conducted in the Department met several challenges disseminate new materials, designing novel materials and molecules of medicinal importance.

2. Learning and Teaching Activities

2.1 Topic wise Delivery Method

Hour Count	Topic	Unit	Mode of Delivery

2.2 **Work Load**

The information below is provided as a guide to assist students in engaging appropriately with the course requirements.

Activity	**Quantity**	**Workload Hours**
Lectures	60	60
Tutorials	15	15
Assignments	5	5
Cycle Test or similar	2	4
Model Test or similar	1	3
University Exam	1	3
	Total	**90 Hours**

3. Tutorial Activities

Tutorial Count	**Topic**
One hour	Will be assigned by the Staff member

4. Laboratory Activities

S. No.	**Semester**	**Course**
1.	I	Practical - I
2.	II	Practical - II
3.	III	Practical - III

5. Field Study Activities

Industrial Visit during third or fourth semester

6. Assessment Activities

6.1 Assessment Principles:

Assessment for this course is based on the following principles:

1. Assessment must encourage and reinforce learning.
2. Assessment must measure achievement of the stated learning objectives.
3. Assessment must enable robust and fair judgments about student performance.
4. Assessment practice must be fair and equitable to students and give them the Opportunity to demonstrate what they learned.
5. Assessment must maintain academic standards.

6.2 Assessment Details:

Assessment Item	Distributed Due Date	Weightage	Cumulative Weightage
Assignment 1	3rd Week	1 %	1 %
Assignment 2	6th Week	1 %	2 %
Cycle Test – I	7th Week	5 %	7 %
Assignment 3	8th Week	1 %	8 %
Assignment 4	11th Week	1 %	9 %
Cycle Test – II	12th Week	5 %	14 %
Assignment 5	14th Week	1 %	15 %
Model Exam	15th Week	5 %	20 %
Seminar	-	5 %	25 %
University Exam	17th Week	75 %	100 %

7. Teaching Methodologies

7.1 Traditional Teaching method like Chalk and Board, Virtual Class room, LCD projector, Smart Class, Video Conference, Guest Lectures.

7.2 Asking students to formulate a problem from a topic covered in a week's time Assignment, Class Test, Slip test

7.3 Asking students to use state-of-the-art technologies/software to solve problems Applications, Use of FORTRAN, ORIGIN software

7.4 Introducing students to applications before teaching the theory

7.5 Training students to engage in self-study without relying on faculty (for example – library and internet search, manual and handbook usage, etc.)

7.5.1. Library, Net Surfing, Manuals, NPTEL Course Materials published in the website

7.5.2. Other University websites.

8. Faculty Course File Structure

a. Academic Schedule
b. Students Name List
c. Time Table
d. Syllabus
e. Lesson Plan
f. Staff Workload
g. Course Design (Content, Course Outcomes (COs), Delivery method, mapping of COs with Programme Outcomes (POs), Assessment Pattern in terms of Revised Bloom's Taxonomy)
h. Sample CO Assessment Tools.
i. Faculty Course Assessment Report (FCAR)
j. Course Evaluation Sheet
k. Teaching Materials (PPT, OHP etc.)
l. Lecture Notes
m. Home Assignment Questions
n. Tutorial Sheets
o. Remedial Class Record, if any.
p. Projects related to the Course
q. Laboratory Experiments related to the Courses
r. Internal Question Paper
s. External Question Paper
t. Sample Home Assignment Answer Sheets
u. Three best, three middle level and three average Answer sheets
v. Result Analysis (CO wise and whole class)
w. Question Bank for Higher studies Preparation (GATE/Placement)
x. List of mentees and their academic achievements

9. Template for PG Programme in Physics

Semester – I	Credit	Hours	Semester - II	Credit	Hours	Semester - III	Credit	Hours	Semester – IV	Credit	Hours
1.1. Core - I	5	7	2.1. Core - IV	5	6	3.1. Core -VII	5	5	4.1. Core - XI	5	6
1.2 Core - II	5	7	2.2 Core - V	5	6	3.2 Core -VIII	5	5	4.2 Core-XII	5	6
1.3 Core – III Practical - I	4	6	2.3 Core – VI Practical - II	4	6	3.3 Core – IX	5	5	4.3 Project with viva voce	8	10
1.4 Discipline Centric Elective - I	3	5	2.4 Discipline Centric Elective – III	3	5	3.4 Core – X Practical - III	4	6	4.4 Elective - VI (Industry / Entrepreneurship) 100% Theory	3	4
1.5 Generic Elective - II	3	5	2.5 Generic Elective - IV	3	5	3.5 Discipline Centric Elective - V	3	4	4.5 Skill Enhancement course / Professional Competency Skill	2	4
			2.6 Online NME I	2	0	3.6 NME II	2	3	4.6 Extension Activity	1	-
			2.7 Human Rights	1	2	3.7 Internship/ Industrial Activity	2	-			
						3.8 Value Added - Peace Education	2	2			
	20	**30**		**23**	**30**		**28**	**30**		**24**	**30**
Total Credit Points -95											

10. Course Structure

FIRST SEMESTER

COURSE CODE	NAME OF THE COURSE	INST. HRS	CREDIT	EXAM HRS	MAX MARKS		
					INT.	EXT.	TOTAL
25UPPHY1C01	Course 1- Mathematical Physics	7	5	3	25	75	100
25UPPHY1C02	Course 2 - Classical Mechanics and Relativity	7	5	3	25	75	100
25UPPHY1C03	Course 3 – Practical I – General Physics	6	4	3	40	60	100
25UPPHY1E__	Discipline Centric Elective – I (Choose any one from the list - I)	5	3	3	25	75	100
25UPPHY1E__	Generic Elective – II (Choose any one from the list - I)	5	3	3	25	75	100

SECOND SEMESTER

COURSE CODE	NAME OF THE COURSE	INST. HRS	CREDIT	EXAM HRS	MAX MARKS		
					INT.	EXT.	TOTAL
25UPPHY1C04	Course 4 – Quantum Mechanics	6	5	3	25	75	100
25UPPHY1C05	Course 5 - Numerical Methods and Computer Programming	6	5	3	25	75	100
25UPPHY1C06	Course 6 – Practical – II -Electronics, Microprocessor and Microcontroller	6	4	3	40	60	100
25UPPHY1E__	Discipline Centric Elective – III (Choose any one from the list - II)	5	3	3	25	75	100
25UPPHY1E__	Generic Elective – IV (Choose any one from the list - I or II)	5	3	3	25	75	100
23UPPGC1H01	Human Rights	2	1	-	25	75	100
-	NME – I (Online Course)	-	2	-	-	-	-

**** Internship will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks Statement.**

THIRD SEMESTER

COURSE CODE	NAME OF THE COURSE	INST. HRS	CREDIT	EXAM HRS	MAX MARKS		
					INT.	EXT.	TOTAL
25UPPHY1C07	Course 7– Electromagnetic Theory	6	5	3	25	75	100
25UPPHY1C08	Course 8 - Spectroscopy	6	5	3	25	75	100
25UPPHY1C09	Course 9 – Thermodynamics and Statistical Mechanics	6	5	3	25	75	100
25UPPHY1C10	Course 10 – Practical- III - Computational Programming and Simulation	6	4	3	40	60	100
25UPPHY1E__	Discipline Centric Elective – III (Choose any one from the list - I or II)	4	3	3	25	75	100
25UPPHY1S__	NME – II	3	2	3	25	75	100
	Value Added – Peace Education	2	2	3	25	75	100
-	Internship / Industrial Activity [Credits]	-	2	-	-	-	

FOURTH SEMESTER

COURSE CODE	NAME OF THE COURSE	INST. HRS	CREDITS	EXAM HRS	MAX MARKS		
					INT.	EXT.	TOTAL
25UPPHY1C11	Course 11– Nuclear and Particle Physics	6	5	3	25	75	100
25UPPHY1C12	Course 12 - Condensed Matter Physics	6	5	3	25	75	100
25UPPHY1C13	Project with Viva-Voce	10	8	3	-	200	200
25UPPHY1E__	Elective - VI Choose any one from the list - III (Industry / Entrepreneurship) 100% Theory	4	3	3	25	75	100
25UPPHY1E__	Skill Enhancement course / Professional Competency Skill (Choose any one from the list -IV)	4	2	3	25	75	100
25UPPHY1X01	Extension Activity	-	1	-	-	-	

ELECTIVE PAPERS

LIST - I

1. Linear and Digital ICs and Applications
2. Physics of Nano Science and Technology
3. Energy Physics
4. Crystal Growth and Thin films
5. Analysis of Crystal Structures
6. Materials Science
7. Digital Communication
8. Communication Electronics

LIST - II

9. Microprocessor 8086 and Microcontroller 8051
10. Plasma Physics
11. Bio Physics
12. Non-linear Dynamics
13. Quantum Field Theory
14. General Relativity and Cosmology
15. Advanced Optics
16. Advanced Mathematical Physics

LIST - III

INDUSTRY ORIENTED ELECTIVE (IOE)

17. Advanced Spectroscopy
18. Characterization of Materials
19. Medical Physics
20. Solid Waste Management
21. Sewage and Waste Water Treatment and Reuse
22. Solar Energy Utilization

(**Note:** Institutions can also frame such IOE courses more suitable for their locality.)

LIST - IV

SKILL ENHANCEMENT COURSES

1. Design and Installation of Solar Photovoltaic System
2. Analytical Instrumental Methods
3. Industrial Semiconductor Devices
4. Silicon Wafer Technology for Photonics
5. Biomaterials
6. Powder X-ray diffraction and analysis

LIST - V

NON MAJOR ELECTIVE COURSES

1. Electronics in Daily Life
2. Geophysics
3. Molecular Biophysics
4. Non-Linear Optics
5. Laser Physics and Applications

11. Testing Pattern (Internal 25 Marks + External 75 Marks)

11.1 Theory Internal: Internal mark distribution for theory paper is as given below.

Test (one best test out of 2 tests)	:	5 Marks
End Semester Model Exam	:	5 Marks
Assignment	:	5 Marks
Seminar	:	5 Marks
Attendance	:	5 Marks
Total	**:**	**25 Marks**

11.2 Semester examination: Theory paper (Bloom's Taxonomy based)

Theory Paper – Question Paper Model

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50 %** **Duration: Three Hours**
Memory Recall/ Example/Counter Example/Knowledge about the Concepts/Understanding (K1 & K2)	Part–A(20 X 1 =20 Marks) Answer ALL questions Each Question carries1 Mark
	FOUR questions from each UNIT
	Question1to Question20
Descriptions/Application (problems) (K3 & K4)	Part – B (3 X 5 =15Marks) Answer any THREE questions Each questions carries 5 Marks
	There shall be FIVE questions covering all the five units
	Question 20 to Question 25
Analysis/Synthesis/Evaluation (K5 & K6)	Part-C (5 X 8 = 40 Marks) Answer ALL questions Each question carries 8 Marks
	Either or Type Both parts of each question from the same UNIT
	Question 26 (a) or 26 (b) to Question 30 (a) or 30 (b)

11.3 Practical Courses

Internal mark distribution for practical course is as below.

Observation : 10 Marks
Cycle Test : 10 Marks
Model Exam : 10 Marks
Record : 10 Marks
Total : 40 Marks

External mark distribution for practical course is as below.

Practical : 40 Marks
Viva-Voce : 10 Marks
Record : 10 Marks
Total : 60 Marks

11.4 Project Mark Distribution

Internal Examiner : 100 Marks [Dissertation (50 Marks) + Viva-Voce (50 Marks)]

External Examiner : 100 Marks [Dissertation (50 Marks) + Viva-Voce (50 Marks)]

Total : 200 Marks

12. Programme Educational Objectives (PEO), Programme Specific Objectives (PSO) and Programme Outcomes (PO)

PEO1: The main aim of the M.Sc (Physics) programme is to have enriched syllabus prepared based on the recent scientific developments in Physics and its interdisciplinary areas and to meet out the requirements of today's academic, research and industry requirements.

PEO2: To teach core subjects of Physics to students to acquire knowledge and to have in-depth understanding about the laws of Physics, concepts, principles and solve analytical problems.

PEO3: To teach practical courses that is to attain knowledge in advanced Physics experiments by independently perform the same, and to clarify the theory learned in core subjects. To introduce skill based courses training the students to handle advanced equipment and computational knowledge.

PEO4: To provide and teach certain popular courses which are not in conventional core courses considered as elective subjects essential for students to take up their research after completion of the postgraduate course.

PEO5: To provide training to students to perform research in physics and interdisciplinary areas, the course has a room that student to carry out research projects and enable the students to obtain research carrier in R & D labs and industry.

Programme Specific Objectives (PSOs)

PSO1: To educate the students how to use the methods of Mathematical Physics in broad spectrum of Physics, particularly in Classical and Quantum Mechanics.

PSO2: To teach Quantum Mechanics to students to understand the microscopic phenomena of all branches of Physics. And to solve various problems using different exact and approximation methods of Quantum Mechanics, which helps students to resolve problems in Quantum Statistics, Spectroscopy of molecules, and Nuclear and Particle Physics.

PSO3: To teach the students to be specialized in Condensed Matter Physics as it provides the fundamental science of solids and liquids, and it is the foundations of most technologies; in-depth understanding of this subject allows the students to do research in both basic sciences and technological applications.

PSO4: To develop the skill on programming and computational simulation techniques to resolve various numerical problems in Physics, Chemistry and Biology.

PSO5: To develop the skill and ability of the students to design, conduct, observe, analyzes and report practical experiments. And to provide research training, particularly in X-ray crystallography, quantum chemical calculations, molecular dynamics simulation, nanoscience, biophysics, biomaterials, synthesis of novel materials, fabrication of solar cells, and energy materials.

Programme Outcomes (Pos)

After completion of the M.Sc., (Physics) programme the students able to

PO1: Apply the knowledge of mathematical physics to understand the complex problems in Quantum physics, spectroscopy, condensed matter physics, nuclear and particle physics.

PO2: Critically analyze the complex problems in different core subject areas of Physics and find the solution.

PO3: Apply the theoretical knowledge and creative ideas allow independently design new electronic devices and establish new research oriented microprocessor and microcontroller experiments.

PO4: Solve the scientific problems via computer simulation and programme writing skills also gained.

PO5: Apply the concepts, acquired research training, experimental/computational experience to work in concerned research areas.

13. Syllabus

CORE COURSES

Course - 01 - MATHEMATICAL PHYSICS	I YEAR – FIRST SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C01	**MATHEMATICAL PHYSICS**	Core	6	1	0	5	7	75

Learning Objectives
➢ To develop knowledge in Mathematical Physics and its applications. ➢ To develop expertise in mathematical techniques required in Physics. ➢ To enhance problem solving skills. ➢ To enable students to formulate, interpret and draw inferences from mathematical solutions.

UNITS	Course Details
UNIT I: VECTOR CALCULUS, MATRICES, TENSORS	Vector calculus: properties of Gradient, divergence and Curl - curvilinear coordinates, spherical and cylindrical coordinates Matrices: Eigen values and Eigen vectors - Cayley-Hamilton theorem - diagonalization of matrix Tensors: Symmetric and antisymmetric - kronecker and Levi Civita tensors.
UNIT II: COMPLEX ANALYSIS	Elements of complex analysis - Analytical functions - Cauchy-Riemann equations - Cauchy theorem - Properties of analytical functions - Contours in complex plane - Integration in complex plane - Deformation of contours - Cauchy integral representation - Taylor and Laurent series - Isolated and essential singular points = Poles, Residues and evaluation of integrals, Cauchy residue theorem and applications of the residue theorem.
UNIT III: LINEAR DIFFERENTIAL EQUATIONS WITH VARIABLE COEFFICIENTS	Legendre's Differential equation: The Power series Solution - Legendre Functions of the first and second kind - Generating Function - Rodrigue's formula - Orthogonal Properties - Recurrence Relations. Bessel's Differential Equation: Power series Solution - Bessel Functions of First and Second kind - Generating Function - Orthogonal Properties - Recurrence Relations. Green's Function: Green' function in one dimension - motion of a particle in a resistive medium - motion of a damped harmonic oscillator - Green's function in three dimensions - solution of Poisson's equation.
UNIT IV: PARTIAL DIFFERENTIAL EQUATION, PROBABILITY THEORY AND ELEMENTS OF GROUP THEORY	Partial differential equations: Laplace, wave and heat equation in two and three dimensions - Boundary value problems and Euler equation. Probability Theory: Theory of Probability and Statistics - Random Variables - Binomial, Poisson and Normal Distributions - Central Limit Theorem - Hypothesis Testing and Data Analysis in Statistics. Elements of group theory: Group postulates - Lie group and generators – representation - Commutation relations, SU(2), O(3).
UNIT V: FOURIER AND LAPLACE TRANSFORMS	Fourier Transform: Infinite Fourier Sine and Cosine transforms - Properties of Fourier transforms - Derivative of Fourier transform - Fourier transform of a derivative - Fourier Sine and Cosine transform of derivatives - Finite Fourier transforms - Applications of Fourier Transforms.

	Laplace Transform: Properties of Laplace transforms - Derivative of Laplace transform - Laplace transform of a derivative - Laplace transform of periodic functions - Inverse Laplace transform and its properties - Inverse Laplace theorem - Convolution theorem - Evaluation of inverse Laplace Transforms by Convolution theorem.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert lectures, Online seminars, webinars on industrial interactions/visits, competitive examinations, employable and communication skill enhancement, social accountability and patriotism
Tutorial	Hermite Differential Equation, Power series Solution, Hermite polynomials, Generating Function, Orthogonality, Recurrence relations, Rodrigues formula, Laguerre Differential equations, The Power series Solution, Generating Function, Rodrigue's formula, Recurrence Relations, Orthogonal Properties, Integral representation of Laguerre differential equations, Beta and Gamma functions , Properties and their relations.
TEXT BOOKS	1. Mathematical Physics - H. K. Dass and Rama Verma, S. Chand Publications, 8th Edition, 2019. 2. Mathematical Physics with Classical Mechanics, Satya Prakash, Sultans Chand & Sons Publications, 7th Edition, 2021. 3. Mathematical Methods for Physicists – A Comprehensive Guide, George Arfken and Hans J Weber, Academic press, 7thEdition, 2012.
REFERENCE BOOKS	1. Advanced Engineering Mathematics, E. Kreyszig, Wiley Eastern, 10th Edition, 2011. 2. Advanced Engineering Mathematics, D. G. Zill and M. R. Cullen, Jones & Bartlett Learning, 6th Edition, 2018. 3. Linear Algebra, S. Lipschutz, Schaum's Series, McGraw - Hill, 4th Edition, 2009. 4. Finite Dimensional Vector Spaces, P. R. Halmos, Benediction Classics, latest Edition, 2023. 5. Advanced Engineering Mathematics, C. R. Wylie and L. C. Barrett, McGraw-Hill, 6th Edition, 1995. 6. Mathematical Physics, P.K. Chattopadhyay, New Age International Private Limited, 3rd Edition, 2022. 7. Mathematical Physics, B. D. Gupta, S Chand and Company Ltd, 4th Edition, 2022.

COURSE OUTCOMES:

At the end of the course the student will be to:

CO1	Understand use of bracket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	**K1 K2 K3 K4 K5 K6**
CO2	Understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	
CO4	Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	
CO5	Find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	3
CO2	2	3	3	3	2
CO3	3	3	3	2	3
CO4	3	3	3	2	3
CO5	3	2	3	2	3

Course - 02 - CLASSICAL MECHANICS AND RELATIVITY	I YEAR – FIRST SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C02	**CLASSICAL MECHANICS AND RELATIVITY**	Core	6	1	0	5	7	75

Learning Objectives

- To understand fundamentals of Classical Mechanics.
- To understand Lagrangian formulation of Mechanics and apply it to solve equation of motion.
- To understand Hamiltonian formulation of Mechanics and apply it to solve equation of motion.
- To discuss the theory of small oscillations of a system and Grasp Hamilton -Jacobi equations
- To learn the relativistic formulation of Mechanics of a system and solve the central force field problems

UNITS	Course Details
UNIT I: PRINCIPLES OF CLASSICAL MECHANICS	Mechanics of a single particle – Mechanics of a system of particles – Conservation laws for a system of particles – Constraints – holonomic & non-holonomic constraints – Generalized coordinates – configuration space – Transformation equations – Principle of virtual work.
UNIT II: LAGRANGIAN FORMULATION	D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.
UNIT III: HAMILTONIAN FORMULATION	Phase space – cyclic coordinates – Hamiltonian function – variational principle – Poisson brackets and canonical transformations - Hamilton's equations from variational principle - Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.
UNIT IV: HAMILTON – JACOBI THEORY AND SMALL OSCILLATIONS	Hamilton - Jacobi equation for Hamilton's principle function - Example: Harmonic oscillator problem - Formulation of the problem – Transformation to normal coordinates – Frequencies of normal modes – Linear triatomic molecule – Action - angle variable - application to Kepler problem in action angle variables
UNIT V: CENTRAL FORCE PROBLEM AND RELATIVITY	Reduction to the equivalent one body problem - Centre of mass Kepler problem: Inverse-Square law of force- – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – four vectors – position, velocity, momentum, acceleration and force in four vector notation and their transformations

Extended Professional Component	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Classical Mechanics, H. Goldstein, Pearson Edu., 3rd Edition, 2022 2. Classical Mechanics, J. C. Upadhyaya, Himalaya Publishing Co., New Delhi, 2019 3. Introduction to Special Theory of Relativity, R. Resnick, Wiley Eastern, New Delhi, 2007 4. Introduction to Classical Mechanics, R. G. Takwala and P.S. Puranik, Tata McGraw Hill, New Delhi, 5th edition 2004. 5. Classical Mechanics, N. C. Rana and P.S. Joag, Tata McGraw Hill, 2001 6. Classical Mechanics, B.D. Gupta and Satya Prakash, Keder Nath Publishers, Meerut, Revised Edition, 2015
REFERENCE BOOKS	1. Mechanics, K. R. Symon, Addison Wesley, London, 1971 2. Classical Mechanics, S. N. Biswas, Books & Allied, Kolkata, 1999 3. Classical Mechanics, Gupta and Kumar, Kedar Nath, 2020 4. Classical Mechanics, T.W.B. Kibble, ELBS, 2004 5. Classical Dynamics, Greenwood, PHI, New Delhi, 2023
TUTORIAL	Newton's laws, Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity Lorentz transformations, relativistic kinematics and mass–energy equivalence. Dynamical systems, Phase space dynamics, stability analysis. Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the fundamentals of classical mechanics.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	
CO3	Apply the principles of Lagrangian, Hamiltonian and Hamilton-Jacobi mechanics to solve the equations of motion of physical systems.	
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	
CO5	Understand and apply the principles of relativistic kinematics and central force to the mechanical systems.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	3	2
CO2	2	3	3	3	2
CO3	2	3	3	3	2
CO4	2	3	3	3	2
CO5	2	3	3	3	2

Course - 03 - PRACTICAL - I - GENERAL PHYSICS	I YEAR – FIRST SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C03	**PRACTICAL - I - GENERAL PHYSICS**	Core	0	0	6	4	6	60

Learning Objectives

- To understand the concept of mechanical behaviour of materials and calculation of same using appropriate equations.
- To calculate the thermodynamic quantities and physical properties of materials.
- To analyze the optical and electrical properties of materials.

(Any Twelve Experiments)

1. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
2. Determination of Viscosity of the given liquid – Meyer's disc
3. Measurement of Coefficient of linear expansion- Air wedge Method
4. B-H loop using Anchor ring.
5. Determination of Thickness of the enamel coating on a wire by diffraction
6. Determination of Rydberg's Constant - Hydrogen Spectrum
7. Fabry Perot etalon - Determination of thickness of air film
8. Determination of Thickness of air film. - Solar spectrum – Hartmann's formula. Edser and Butler fringes.
9. Measurement of Band gap energy- Thermistor
10. Determination of Planck Constant – LED Method
11. Determination of Specific charge of an electron – Thomson's method.
12. Determination of Compressibility of a liquid using Ultrasonics
13. Determination of Wavelength, Separation of wavelengths and Refractive index - Michelson Interferometer
14. GM counter – Characteristics, inverse square law and absorption coefficient.
15. Measurement of Conductivity - Four probe method.
16. Arc spectrum – Iron.
17. Molecular spectra – AlO band.
18. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
19. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
20. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
21. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench
22. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient
23. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
24. Determination of Stefan's constant of radiation from a hot body
25. Measurement of Susceptibility of liquid - Quincke's method
26. B-H curve using CRO
27. Measurement of Magnetic Susceptibility - Guoy's method
28. LG Plate

29.	Arc spectrum: Copper
30.	Determination of Solar constant
31.	Determination of e/m - Millikan's method
32.	Miscibility measurements using ultrasonic diffraction method
33.	Determination of Thickness of thin film. - Michelson Interferometer
34.	GM counter – Feather's analysis: Range of Beta rays
35.	Iodine absorption spectra
36.	Molecular spectra – CN bands
37.	Determination of Refractive index of liquids using diode Laser/ He – Ne Laser
38.	Determination of Numerical Apertures and Acceptance angle of optical fibers using Laser Source.
39.	Measurement of Dielectricity - Microwave test bench
40.	Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility
41.	Interpretation of vibrational spectra of a given material
42.	LVDT Characteristics curve and displacement measurement
43.	Determine the functional group of given sample by using FT-IR spectrometer.
44.	Determination of lattice parameters and crystallite size calculation from Powder X-ray diffraction patterns of given crystal.
45.	Polarization analysis and identification of crystal defects using polarization microscope.

Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Practical Physics, S.L.Gupta and V.Kumar, Pragati Edition,2018. 2. An Advanced Course in Practical Physics - D. Chattopadhyay, P. C. Rakshit; New Central Book Agency (P) Ltd; 8th Edition, 2007. 3. A Textbook of Advanced Practical Physics - S. K. Ghosh; New Central; Fourth Edition, 2000.
REFERENCE BOOKS	1. Physical Methods, Instruments and Measurements - Vol. 1-4, - Yuri M. Tsipenyuk; Russian Academy of Sciences, Russia, 2009. 2. Encyclopedia of Physical Science and Technology: Measurements Techniques and Instrumentation - Robert Allen Meyers Academic Press, 2007.

Course - 04 - QUANTUM MECHANICS	II YEAR – SECOND SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C04	**QUANTUM MECHANICS**	Core	5	1	0	5	6	75

Learning Objectives

- To develop the physical principles and the mathematical background important to Quantum Mechanical descriptions.
- To describe the propagation of a particle in a simple, one-dimensional potential.
- To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.
- To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
- To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

UNITS	Course Details
UNIT I: BASIC FORMALISM	Interpretation of the wave function –wave particle duality-De Broglie hypothesis - Time dependent Schrodinger equation – Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen values – Hermitian operator – Postulates of quantum mechanics – Simultaneous measurability of observables – General uncertainty relation
UNIT II: ONE DIMENSIONAL AND THREE DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS, SCATTERING THEORY	Particle in a box - Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator Elementary theory of scattering: phase shifts, partial waves, Born approximation.
UNIT III: MATRIX FORMULATION OF QUANTUM THEORY AND EQUATION OF MOTION,	Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation **Relativistic quantum mechanics**: Klein –Gordon and Dirac equations semi classical theory of application

RELATIVISTIC QUANTUM MECHANICS	
UNIT IV: APPROXIMATION METHODS	Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in hydrogen atom – Ground and excited state – Time dependent perturbation theory and Fermi's Golden rule - Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – Bohr - Sommer field quantization condition – Application to simple harmonic oscillator.
UNIT V: ANGULAR MOMENTUM, IDENTICAL PARTICLES	Eigen value spectrum of general angular momentum – Ladder operators and their algebra - commutators – Matrix representation – Spin angular momentum – Addition of angular momenta - Stern-Gerlach experiment – CG coefficients. Identical Particles and Spin Identical Particles – symmetry and antisymmetric wave functions - exchange degeneracy – Spin and statistics - Pauli's exclusion principle - Slater determinant
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, McGraw Hill Education, 2nd Edition, 2017. 2. Quantum Mechanics, G. Aruldhas, Prentice Hall of India, 2nd Edition, 2013. 3. Introduction to Quantum Mechanics, David J. Griffiths and Darrell F. Schroeter, Cambridge University Press, 4thEdition, 2019. 4. Quantum Mechanics, SatyaPrakash and Swati Saluja, KedarNath, Ram Nath and Co. Publications, 2019. 5. Quantum Mechanics: Theory and Applications, A. Ghatakand S. Lokanathan, Kluwer Academic Publishers, 2004.
REFERENCE BOOKS	1. Quantum Mechanics, E. Merzbacher, John Wiley and Sons, New York, 2nd Edition,1970. 2. Quantum Mechanics, V. K. Thankappan, Wiley Eastern Ltd, New Delhi, 2nd Edition, 1985. 3. Quantum Mechanics, L. D. Landau and E. M. Lifshitz, Pergomon Press, Oxford, 1stEdition, 1976. 4. Quantum Mechanics, S. N. Biswas, Books and Allied Ltd., Kolkata, 1999. 5. Quantum Mechanics, V. Devanathan, Alpha Science International Ltd, Oxford, 2nd Edition, 2011.
Tutorial	Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-

	function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection. Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Demonstrates a clear understanding of the basic postulates of Quantum Mechanics which serve to formalize the rules of Quantum Mechanics	**K1 K2 K3 K4 K5 K6**
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	
CO3	Can discuss the various representations, space time symmetries and formulations of time evolution	
CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems	
CO5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	2	3	3	2	3
CO4	3	3	3	3	3
CO5	3	3	3	2	3

Course - 05 - NUMERICAL METHODS AND COMPUTER PROGRAMMING	I YEAR – SECOND SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C05	**NUMERICAL METHODS AND COMPUTER PROGRAMMING**	Core	5	1	0	5	6	75

Learning Objectives

- To make students to understand different numerical approaches to solve a problem.
- To understand the basics of programming
- To relate simultaneous linear equations and their matrix representation distinguish between various methods in solving simultaneous linear equations.
- To understand, how interpolation will be used in various realms of physics and apply to some simple problems the newton forward and backward interpolation
- To understand the basics of Fortran-programming and conditional statements.

UNITS	Course Details
UNIT I: SOLUTIONS OF EQUATIONS	Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations - Zeros of polynomials – Roots of polynomials, nonlinear algebraic equations and transcendental equations using Bisection and Newton - Raphson methods – Convergence of solutions in Bisection and Newton-Raphson methods – Limitations of Bisection and Newton-Raphson methods.
UNIT II: LINEAR SYSTEM OF EQUATIONS	Simultaneous linear equations and their matrix representation – Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations – Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method - Eigen values and eigenvectors of matrices – Direct method - Power method and Jacobi Method to find the Eigen values and Eigen vectors.
UNIT III: INTERPOLATION AND CURVE FITTING	Interpolation with equally spaced points - Newton forward and backward interpolation - Interpolation with unevenly spaced points - Lagrange interpolation – Extrapolation - Curve fitting – Method of least squares – Fitting a polynomial.
UNIT IV: DIFFERENTIATION , INTEGRATION AND SOLUTION OF DIFFERENTIAL EQUATIONS	Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rule – Error estimates – Gauss-Legendre, Gauss-Laguerre, Gauss-Hermite and Gauss-Chebyshev quadrature – solution of ordinary differential equations – Euler and RungaKutta methods.
UNIT V: PROGRAMMING WITH FORTRAN	Integer and floating point arithmetic, Precision, Variable types, Arithmetic statements, Input and output statements, Control statements, Executable and non-executable statements, Arrays, Repetitive and logical structures, Subroutines and functions, Operation with files, Creation of executable programs. – Programs for the following computational methods: (a) Zeros of polynomials by the bisection method, (b) Zeros of polynomials/non-linear

	equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange Interpolation, (d) Trapezoidal and Simpson's Rules, (e) Solution of first order differential equations by Euler's method.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. V. Rajaraman, 2019, Computer oriented Numerical Methods, 4th Edition, PHI, New Delhi 2. M. K. Jain, S. R. Iyengar and R. K. Jain, 2022, Numerical Methods for Scientific and Engineering Computation, 8th Edition, New Age Intl., New Delhi 3. S. S. Sastry, 2012, Introductory Methods of Numerical analysis, 5th Edition, PHI, New Delhi 4. F. Scheid, 1998, Numerical Analysis, 2nd Edition, Schaum's series, McGraw Hill, New York 5. W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, 2007, Numerical Recipes in FORTRAN, 3rd Edition, Cambridge Univ. Press 6. P. Kandasamy, K. Thilagavathy and K. Gunavathi, 2022, Numerical methods, S. Chand and Company Ltd, New Delhi
REFERENCE BOOKS	1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill, 2. B. F. Gerald, and P. O. Wheatley, 2007, Applied Numerical analysis, 7th Edition, Addison-Wesley, MA. 3. B. Carnahan, H. A. Luther and J. O. Wilkes, 1969, Applied Numerical Methods, Wiley, New York. 4. S. S. Kuo, 1996, Numerical Methods and Computers, Addison-Wesley. 5. V. Rajaraman, 2010, Programming in FORTRAN / Programming in C, PHI, New Delhi
TUTORIALS	Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Recall the transcendental equations and analyze the different root finding methods. Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	**K1 K2 K3 K4 K5 K6**
CO2	Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.	
CO3	Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation	

CO4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simson's method of numerical integration.	
CO5	Understand the basics of Fortran-programming and conditional statements.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	1	2
CO2	3	2	3	1	2
CO3	3	2	3	1	2
CO4	3	2	3	1	2
CO5	3	2	3	1	2

Course 6 - PRACTICAL – II – ELECTRONICS, MICROPROCESSOR AND MICROCONTROLLER	I YEAR - SECOND SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C06	**PRACTICAL – II - ELECTRONICS, MICROPROCESSOR AND MICROCONTROLLER**	Core	0	0	6	4	6	60

Learning Objectives

- To observe the applications of FET and UJT.
- To study the different applications of operational amplifier circuits.
- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- To write and verify the assembly language program using microprocessor 8085 for various applications.
- To write the assembly language program using microcontroller 8051.

Course Details

(Any Twelve Experiments)

1. Construction of relaxation oscillator using UJT
2. FET CS amplifier- Frequency response, input impedance, output impedance
3. Study of important electrical characteristics of IC741.
4. V- I Characteristics of different colours of LED.
5. JFET – Characteristics and Design of amplifier.
6. Photo Transistor characteristic
7. Photo Diode characteristic
8. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
9. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
10. Construction of Schmidt triggers circuit using IC 741 for a given hysteresis- application as squarer.
11. Construction of square wave Triangular wave generator using IC 741
12. Construction of pulse generator using the IC 741 – application as frequency divider
13. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
14. Study of Binary to Gray and Gray to Binary code conversion.
15. Study of R-S, clocked R-S and D-Flip flop using NAND gates
16. Study of J-K, D and T flip flops using IC 7476/7473
17. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
18. Arithmetic Operations using Op- amp IC 741 (Addition, Subtraction, Multiplication & Division)
19. Study of Arithmetic logic unit using IC 74181.
20. Construction of Encoder and Decoder circuits using ICs.
21. IC 7490 as scalar and seven segment display using IC7447
22. Solving simultaneous equations – IC 741 / IC LM324

23. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter
24. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
25. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193
26. Construction of square wave generator using IC 555 – Study of VCO
27. Construction of Schmidt trigger circuit using IC555 for a given hysteresis – Application as squarer
28. Construction of pulse generator using the IC 555 – Application as frequency divider
29. BCD to Excess- 3 and Excess 3 to BCD code conversion
30. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474
31. Construction of Multiplexer and Demultiplexer using ICs.
32. Printed Circuit Board – Designing and testing.
33. Computer assembling and testing.

Microprocessor 8085:

34. Arithmetic operations- 8 bit and 16 bit
35. Code conversion (BCD to Binary and Binary to BCD).
36. Arranging numbers in ascending and descending orders.
37. Temperature Conversions (F to C & C to F).
38. Determination of factorial of the given number.
39. Square and square root of the given number.
40. Sum of the "n" numbers.
41. Solving simple expressions
42. ADC and DAC interfacing
43. ALP to control and modify Traffic light signal.
44. Controlled rotation of the shaft of a stepper motor.

Microcontroller 8051:

45. Arithmetic operations- 8 bit & 16 bit
46. Solving simple expressions
47. Array operations (Biggest and Smallest number).
48. Square and square root of the given number.
49. Stepper motor interfacing.
50. Seven segment display.
51. ADC interfacing

TEXT BOOKS	1. Practical Physics, Gupta and Kumar, Pragati Prakasan,2017. 2. Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences,2001. 3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition,2002. 4. Electronic lab manual Vol I, K A Navas, Rajath Publishing,2006. 5. Electronic lab manual Vol II, K A Navas, PHI eastern Economy Edition 2007.
REFERENCE BOOKS	1. An advanced course in Practical Physics, D. Chattopadhayay, C. R Rakshit, New Central Book Agency Pvt. Ltd, 2011. 2. Advanced Practical Physics, S.P Singh, Pragati Prakasan,2017. 3. A course on experiment with He-Ne Laser, R. S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd,1991. 4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing,2010. 5. Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi,2005.

Course - 7 - ELECTROMAGNETIC THEORY	II YEAR - THIRD SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C07	**ELECTROMAGNETIC THEORY**	Core	4	1	0	5	5	75

Learning Objectives

- To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables
- To understand Biot – Savart's law and Ampere's circuital law
- To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws
- To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves
- To grasp the concept of plasma as the fourth state of matter

UNITS	Course Details
UNIT I: ELECTROSTATICS	Gauss's law its applications - Boundary value problems - Laplace and Poisson equations – Boundary conditions and uniqueness theorem – Laplace equation in three dimensions – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems. Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.
UNIT II: MAGNETOSTATICS	Biot-Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.
UNIT III: MAXWELL EQUATIONS	Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution - Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.
UNIT IV: WAVE PROPAGATION	Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface -Waves in free space, dielectric and conducting media – Fresnel's law, interference, coherence and diffraction - Propagation of waves in a rectangular wave guide. Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole - Dynamics of charged particles in static and uniform electromagnetic fields

UNIT V: ELEMENTARY PLASMA PHYSICS	The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto-hydrodynamic waves - Alfven waves and magnetosonic waves.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. D. J. Griffiths, 2021, Introduction to Electrodynamics, 4th Edition, Prentice-Hall of India, New Delhi. 2. J. R. Reitz, F. J. Milford and R. W. Christy, 2008, Foundations of Electromagnetic Theory, 4th Edition, Narosa Publishing House, New Delhi. 3. J. D. Jackson, 2007, Classical Electrodynamics, Wiley Eastern Ltd. New Delhi. 4. J. A. Bittencourt, 2004, Fundamentals of Plasma Physics, 3rd Edition,Springer-Verlag New York Inc. 1. S. L. Gupta, V. Kumar, S.P. Singh, 2023, Electrodynamics, 24th Edition, Pragati Prakashan, Meerut.
REFERENCE BOOKS	1. W. Panofsky and M. Phillips, 2012, Classical Electricity and Magnetism, 2nd Edition, Dover Publications Inc, USA. 2. J. D. Kraus and D. A. Fleisch, 2017, Electromagnetics with Applications, 5th Edition, Boston: WCB/McGraw-Hill. 3. B. Chakraborty, 2010, Principles of Electrodynamics, Books and Allied Ltd, Kolkata. 4. P. Feynman, R. B. Leighton and M. Sands, 1998, The Feynman Lectures on Physics, Vols. 2, Narosa Publishing House, New Delhi. 1. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA.
TUTORIALS	Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields. Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

COURSE OUTCOMES:

CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	**K1 K2 K3 K4 K5**
CO2	Use Biot-Savart's law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems	
CO3	Apply Maxwell's equations to describe how electromagnetic field behaves in different media	
CO4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

At the end of the course the student will be able to:

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

Course 08 - SPECTROSCOPY		II YEAR – III SEMESTER						
Course Code	**Name of the course**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
25UPPHY1C 08	**SPECTROSCOPY**	Core	4	1	0	5	5	75

Learning Objectives

- To comprehend the theory behind different spectroscopic methods
- To know the working principles along with an overview of construction of different types of spectrometers involved
- To explore various applications of these techniques in R &D.
- Apply spectroscopic techniques for the qualitative and quantitative analysis of various chemical compounds.
- Understand this important analytical tool

UNITS	Course Details
UNIT I: **ELECTRONIC SPECTROSCOPY**	Quantum states of an atom - Electronic wave functions – Shape of atomic orbitals - Atomic quantum numbers – Hydrogen atom spectrum – Relativistic corrections of energy levels - Spectrum of lithium and helium atoms – LS and JJ couplings – Selection rules - Hyperfine structure – Isotopic shift – Width of spectral lines - Zeeman effect – Paschen-Back effect – Stark effect - Electronic spectra of diatomic molecules – Born- Oppenheimer approximation – Vibrational course structure – Frank- Condon principle
UNIT II: **MICROWAVE SPECTROSCOPY**	Rotational spectra of diatomic molecules - Rigid rotor (Diatomic molecules) - reduced mass – rotational constant - Effect of isotopic substitution - Non rigid rotator – Centrifugal distortion constant- Intensity of spectral lines - Polyatomic molecules – Linear – symmetric & asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques – block diagram - Information derived from rotational spectra - Problems.
UNIT III: **INFRARED SPECTROSCOPY**	Vibrations of simple harmonic oscillator – zero-point energy - Anharmonic oscillator – Fundamentals, overtones and combinations - Diatomic vibrating rotator - PR branch – PQR branch - Fundamental modes of vibration of H_2O and CO_2 - Introduction to application of vibrational spectra - IR spectrophotometer instrumentation (Double beam spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra – Remote analysis of atmospheric gases like N_2O using FTIR by National Remote Sensing Centre (NRSC), India– Other simple applications
UNIT IV: **RAMAN**	Theory of Raman scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecules - symmetric

SPECTROSCOPY	top molecules – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle - determination of N_2O structure - Instrumentation technique and block diagram - Structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy - SERS
UNIT V: **RESONANCE SPECTROSCOPY**	Nuclear and electron spin-Interaction with magnetic field - Population of energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of hydrogen nuclei - Indirect spin -spin interaction – interpretation of NMR spectra of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan Electron Spin Resonance: Basic principle – Total Hamiltonian (Direct dipole-dipole interaction and Fermi contact interaction) – Hyperfine structure (Hydrogen atom) – ESR Spectra of free radicals – g-factors – Instrumentation - Medical applications of ESR
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Fundamentals of Molecular Spectroscopy, C N Banwell and E M McCash, Tata McGraw–Hill, New Delhi, 4th Edition,1994. 2. Molecular Structure and Molecular Spectroscopy, G Aruldhas, Prentice–Hall of India, New Delhi, 1994. 3. Vibrational Spectroscopy and Applications, D.N. Satyanarayana, New Age International Publication,2001 4. Spectroscopy, B.K. Sharma, Goel Publishing House Meerut, 2015. 5. Spectroscopy of Organic Compounds, P.S. Kalsi., New Age International Publishers, 7th Edition, 2016
REFERENCE BOOKS	1. Molecular Spectroscopy, J L McHale, Pearson Education India, New Delhi, 2008. 2. Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, J M Hollas, Royal Society of Chemistry, RSC, Cambridge, 2002. 3. Spectroscopy Vol. I, B. P. Straughan and S. Walker, Chapman and Hall, New York, 1976. 4. Introductory Quantum Chemistry, K. Chandra, Tata McGraw Hill, New Delhi, 1989. 5. Laser Spectroscopy: Basic concepts and Instrumentation, W. Demtroder,Springer Link.
Tutorial	Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for

	energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation.	
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	
CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	
CO5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a simple UV spectrum.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 – Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	3
CO2	2	2	2	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Course 9 - THERMODYNAMICS AND STATISTICAL MECHANICS	II YEAR - THIRD SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C09	**THERMODYNAMICS AND STATISTICAL MECHANICS**	Core	4	1	0	5	5	75

Learning Objectives

- To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics
- To identify the relationship between statistic and thermodynamic quantities
- To comprehend the concept of partition function, canonical and grand canonical ensembles
- To grasp the fundamental knowledge about the three types of statistics
- To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time

UNITS	Course Details
UNIT I: STATISTICAL MECHANICS AND THERMODYNAMICS	Laws of Thermodynamics and their consequences - Thermodynamic potentials – Maxwell relations - macrostates, microstates, chemical potential and phase equilibria - Phase space and ensembles – Trajectories and density of states - Entropy - Connection between statistics and thermodynamics – Gibbs-Duhem relation for entropy - Entropy of an ideal gas using the micro canonical ensembles - Entropy of mixing and Gibb's paradox - Liouville's theorem
UNIT II: THEORY OF ENSEMBLES	Classification of ensembles - Micro canonical, Canonical and Grand canonical ensembles - Partition function - Relation between grand canonical and canonical partition functions - Energy and density fluctuations.
UNIT III: CLASSICAL AND QUANTUM STATISTICS	Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Maxwell-Boltzmann distribution law for microstates in a classical gas -Fermi-Dirac statistics – Ideal Bose and Fermi gas – Degeneracy - Bose-Einstein statistics - Non-interacting Bose gas and thermodynamic relations - BE, FD, MB distributions using GCE partition functions. Black body radiation and Plank's distribution law-Principle of detailed balance
UNIT IV: REAL GAS, ISING MODEL AND TRANSPORT PROCESS	Classical and quantum cluster expansion - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model in one, two, three dimensions - Exact solutions. Fluctuations: Fluctuations in energy and enthalpy - Diffusion equation - transport phenomena Random walk - Brownian motion - All speeds and all directions- Introduction to nonequlibrium process
UNIT V: HEAT CAPACITIES AND PHASE TRANSITIONS	Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas- Heat capacity of Bose gas – Phase Equilibrium - Gibb's phase rule - Diamagnetism, Paramagnetism and Ferromagnetism-Phase transitions – Landau's theory of

	phase transition - Classification of phase transitions by order and by symmetry – Critical indices – Bose -Einstein condensation
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Introduction to Statistical Mechanics, S. K. Sinha, Tata McGraw Hill, New Delhi, 2005 2. Statistical Mechanics, B. K. Agarwal and M. Eisner, Second Edition, New Age International, New Delhi, 1998 3. Statistical Mechanics: An Introductory Text, J. K. Bhattacharjee, Allied Publication, New Delhi, 1996 4. Fundamentals of Statistical and Thermal Physics, F. Reif, McGraw-Hill, New York, 1965 5. Heat and Thermodynamics, M. K. Zemansky, 5th edition, McGraw-Hill, New York, 1968
REFERENCE BOOKS	1. Statistical Mechanics, R. K. Pathria, 2nd edition, Butterworth-Heinemann, New Delhi, 1996 2. Statistical Physics, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1969 3. Statistical Mechanics, K. Huang, Taylor and Francis, London, 2005 4. Thermodynamics and Statistical Mechanics, W. Greiner, L. Neise, and H. Stoecker, Springer Verlag, New York, 2005 5. Thermal Physics, A. B. Gupta and H. Roy, Books and Allied, Kolkata, 2020
Tutorial	Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law First and second order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. Describe the peculiar behaviour of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	
CO3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	
CO4	To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	
CO5	To discuss and examine the thermodynamical behaviour of gases under fluctuation and also using Ising model	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate;K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	1	1
CO2	3	3	3	1	1
CO3	3	3	3	1	1
CO4	3	3	3	1	1
CO5	3	3	3	1	1

Course - 10 - PRACTICAL – III - COMPUTATIONAL PROGRAMMING AND SIMULATION	II YEAR - THIRD SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C10	**COMPUTATIONAL PROGRAMMING AND SIMULATION**	Core	0	0	6	4	6	60

Learning Objectives

- The aim and objective of the course on Computational Practical is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using any high level language such as FORTRAN
- To equip the computational skill using various mathematical tools.
- To apply the software tools to explore the concepts of physical science.
- To approach the real time activities using physics and mathematical formulations.

Course Details

(Any Twelve Experiments)

1. Program to Read a set of numbers, count them and print the largest and smallest numbers in the list and their positions in the list.
2. Lagrange interpolation with Algorithm, Flow chart and output.
3. Newton forward interpolation with Algorithm, Flow chart and output.
4. Newton backward interpolation with Algorithm, Flow chart and output.
5. Program to find ascending and descending order of numbers and characters.
6. Program to find Eigen values and Eigen vectors of a matrix.
7. Program for matrix addition, subtraction and multiplication.
8. Program for transpose of a matrix.
9. Program to solve simultaneous linear algebraic equation - Gauss elimination method.
10. Program to solve simultaneous linear algebraic equation - Gauss-Seidel iteration method.
11. Program to integrate any function or tabulated data using trapezoidal rule.
12. Program to integrate any function or tabulated data using Simpson‟s rule.
13. Program to compute the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method.
14. Least-Square curve fitting - Straight line fit.
15. Roots of algebraic equations – Newton-Raphson method.
16. Numerical differentiation – Euler method.
17. Evaluation of definite integrals – Monte Carlo method.
18. Numerical simulation of wave functions of simple harmonic oscillator.
19. Computer simulation of Kroning-Penney model.
20. Computer simulation of Leneard-Jones potential, binding parameters, elastic constants.
21. Computation of wave functions and their interpretation for various potentials.

22. Simulation of a wave functions for a particle in a critical box. 23. Write a program to solve heat equation – finite difference method.	
TEXT BOOKS	1. Numerical methods using Matlab – John Mathews & Kurtis Fink, Prentice Hall, New Jersey, 4th edition, 2006. 2. Numerical methods in Science and Engineering - M.K. Venkataraman, National Publishing Co. Madras, Fifth edition, 1999. 3. Computer Oriented Numerical Methods, V. Rajaraman, PHI learning, Fourth edition, 2019. 4. Numerical Methods for Scientific and Engineering Computation, M.K. Jain, S.R. Iyengar and R.K. Jain, New Age International, Sixth edition, 2012. 5. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI, 5th edition, 2012.
REFERENCE BOOKS	1. Elementary Numerical Analysis, Updated with MATLAB (Classics in Applied Mathematics), S.D. Conte and C. de Boor, Society for Industrial & Applied Mathematics, Latest Edition, 2018. 2. Applied Numerical Analysis, B.F. Gerald and P.O. Wheately, Addison Wesley Reading, 5th Edition, 1994. 3. Applied Numerical Methods, B. Carnahan, H.A. Luther and J.O. Wikes, Wiley, 1st edition, 1969. 4. Numerical Methods and Computers, S.S. Kuo, Addison - Wesley, London, 1996. 5. Programming in FORTRAN/ Programming in C, V. Rajaraman PHI, ,New Delhi, 1997.

Course 11 - NUCLEAR AND PARTICLE PHYSICS	II YEAR – FOURTH SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C11	NUCLEAR AND PARTICLE PHYSICS	Core	5	1	0	5	6	75

Learning Objectives

- Introduces students to the different models of the nucleus in a chronological order
- Imparts an in-depth knowledge on the nuclear force
- Introduces the types of nuclear reactions and their principles
- Provides students with details of nuclear decay with relevant theories
- Exposes students to the Standard Model of Elementary Particles and Higgs boson.

UNITS	Course Details
UNIT I: **NUCLEAR MODELS**	Basic nuclear properties-Binding energy – Weizacker semi-empirical mass formula - Liquid drop model - Bohr Wheeler theory of fission – Shell model – Spin-orbit coupling – Magic numbers – Angular momenta and parity of ground states – Magnetic moment – Schmidt model – Electric Quadrapole moment - Bohr and Mottelson collective model – Rotational and vibrational bands.
UNIT II: **NUCLEAR FORCES**	Nucleon – Nucleon interaction – Tensor forces – Properties of nuclear forces – Ground state of deuteron – Exchange forces - Meson theory of nuclear forces – Yukawa potential – Nucleon-nucleon scattering – Effective range theory – Spin dependence of nuclear forces - Charge independence and charge symmetry – Isospinformalism.
UNIT III: **NUCLEAR REACTIONS**	Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – Scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear chain reaction – Four factor formula.
UNIT IV: **NUCLEAR DECAY**	Alpha decay - Beta decay – Continuous beta spectrum – Fermi theory of beta decay - Comparative half-life –Fermi Kurie Plot – Mass of neutrino – allowed and forbidden decay — Neutrino physics – Helicity - Parity violation - Gamma decay – Multipole radiations – Angular correlation - Internal conversion – Nuclear isomerism – Angular momentum and parity selection rules.
UNIT V: **ELEMENTARY PARTICLES**	Classification of elementary particles – Types of interaction and conservation laws – Families of elementary particles – Isospin – Quantum numbers – Strangeness – Hypercharge and Quarks – SU (2) and SU (3) groups - Gell Mann matrices– GellMann Okuba Mass formula - Quark Model- Standard model of particle physics – Higgs boson.

Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Nuclear Physics , D.C. Tayal, Himalaya Publishing House, 2011 . 2. Introductory Nuclear Physics , K. S. Krane, John Wiley & Sons ,2008. 3. Nuclear Physics , R. Roy and P. Nigam, New Age Publishers, 1996. 4. Nuclear Physics – An introduction, S. B. Patel, New Age International Pvt Ltd Publishers, 2011. 5. Source Book of Atomic Energy, S. Glasstone, Van Nostrand Reinhold Inc.,U.S., 3rd Revised edition, 1968.
REFERENCE BOOKS	1. The Physics of elementary particles, L. J. Tassie , Prentice Hall Press, 1973. 2. Introduction to Nuclear Physics, H. A. Enge, Addison Wesley, Publishing Company. Inc. Reading. New York, 1974. 3. Nuclear Physics , Kaplan , Narosa, 2nd Edition, 2002. 4. Concepts of Nuclear Physics , Bernard L Cohen, McGraw Hill Education (India) Private Limited, 1st edition, 2001. 5. Concepts of Nuclear Physics, B.L. Cohen, TMCH, New Delhi, 1971.
Tutorial	Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi- empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	**K1 K2 K3 K4 K5 K6**
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	2
CO2	3	3	2	2	1
CO3	3	3	1	2	1
CO4	3	3	2	3	2
CO5	3	3	2	3	2

Course 12 - CONDENSED MATTER PHYSICS	II YEAR – FOURTH SEMESTER

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1C 12	**CONDENSED MATTER PHYSICS**	Core	5	1	0	5	6	75

Learning Objectives

- To describe various crystal structures, symmetry and to differentiate different types of bonding.
- To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat.
- To critically assess various theories of electrons in solids and their impact in distinguishing solids.
- Outline different types of magnetic materials and explain the underlying phenomena.
- Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

UNITS	Course Details
UNIT I: CRYSTAL PHYSICS	Types of lattices - Miller indices –Crystal diffraction - Bragg's law – Reciprocal lattice (SC, BCC, FCC). Structure and properties of liquid crystals. Diffraction conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Ewald's sphere construction
UNIT II: LATTICE DYNAMICS AND THERMAL PROPERTIES	Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Theory of vibrations of monoatomic and diatomic lattices- Acoustical, optical, transverse and longitudinal modes - Phonon momentum - Inelastic scattering by phonons - Debye's theory of lattice heat capacity - Thermal conductivity - Umkalapp processes - Specific heat capacity of solids-Einstein & Debye models
UNIT III: THEORY OF METALS AND SEMICONDUCTORS	Free electron gas in three dimensions - Electronic heat capacity - Band theory of metals and semiconductors - Bloch theorem - Nearly free electron model - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature dependence - Mobility - Impurity conductivity – Hall effect - Fermi surfaces and construction - Hall effect - Thermo electric power.
UNIT IV: DIELECTRICS AND MAGNETISM	Types of polarization - Clausius-Mossotti relation -Diamagnetism - Quantum theory of paramagnetism - Quenching of orbital angular momentum - Curie point - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature - Spintronics
UNIT V: Superconductivity	Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Type I and II superconductors - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS)

	Theory - Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature superconductors – SQUIDS & Superfluidity
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars, Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Introduction to Solid State Physics, C. Kittel, 8th Edition, Wiley, New York, 2012 2. Solid State Physics, Rita John, Tata McGraw Hill Publication, 2014 3. Solid State Physics, A. J. Dekker, Macmillan India, New Delhi, 2008 4. Elementary Solid State Physics – Principles and Applications, M. Ali Omar, Addison-Wesley, 1974 5. Introductory Solid State Physics, H. P. Myers, 2nd Edition, Viva Book, New Delhi, 1998
REFERENCE BOOKS	1. Solid State Physics, J. S. Blakemore, 2nd Edition, W.B. Saunders, Philadelphia, 1974 2. The Solid State, H. M. Rosenburg, 3rd Edition, Oxford University Press, Oxford, 1993 3. Principles of the Theory of Solids, J. M. Ziman, Cambridge University Press, London, 1971 4. Introduction to Superconductivity, C. Ross-Innes and E. H. Rhoderick, Pergamon, Oxford, 1976 5. Elements of Solid State Physics, J. P. Srivastava, Prentice-Hall of India, New Delhi, 2001
TUTORIAL	Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter: translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	**K1** **K2** **K3** **K4** **K5**
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	
CO3	Student will be able to comprehend the heat conduction in solids	
CO4	Student will be able to generalize the electronic nature of solids from band theories.	
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	3	3	2	3
CO4	2	2	2	2	2
CO5	2	2	2	2	2

ELECTIVE COURSES

ELECTIVE - LIST 1 – 1. LINEAR AND DIGITAL ICs & APPLICATIONS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E01	**LINEAR AND DIGITAL ICs AND APPLICATIONS**	Elective	4	1	0	3	5	75

Learning Objectives

- To introduce the basic building blocks of linear integrated circuits & Op-Amp.
- To teach the linear and non-linear applications of operational amplifiers.
- To introduce the theory and applications of active filters and PLL.
- To introduce the concepts of waveform generation and introduce one special function ICs.
- Exposure to digital IC 's

UNITS	Course Details
UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER	**Integrated circuits**: Introduction – classification of ICs by its structure and function – basic bipolar integrated circuits – theories in diffusion impurities – integrated resistors -integrated capacitors – metal-semiconductor contact. **Operational amplifier:** Basic information of Op-Amp – the ideal operational amplifier - inverting, non-inverting, - voltage follower – summing amplifier
UNIT II: APPLICATIONS OF OP-AMP	**Linear Applications of Op-Amp:** Instrumentation amplifier – peak detector, clipper, clamper - V/I converter with floating load/grounded load **–** low voltage DC and AC voltmeter – I/V converter. **Non-linear Applications of Op-amp:** Sample and Hold circuit, Log and Antilog amplifier, multiplier, divider, differentiator, integrator Comparators, Schmitt trigger, - Astable-multi-vibrator – Monostable multi-vibrator – sine wave generators.
UNIT III: ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS	**Active Filters**: Introduction – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters. **Timer:** Introduction to IC 555 timer - Description of functional diagram – Monostable, Astable, Schmitt-trigger operations. **Phase Locked Loops:** Introduction - Phase detector/comparator – voltage-controlled oscillator (VCO) - Monolithic Phase-locked loop – PLL applications
UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS	**Voltage Regulator**: Introduction, Series Op-Amp regulator - IC Voltage Regulators - IC 723 general purpose regulators - Switching Regulator **Data conversion circuits**: Introduction, weighted resistor DAC, R-2R ladder DAC – D/A converter specifications – current steering & voltage switching mode – A/D converter specifications – simultaneous A/D converters, counter type, successive approximation type, single, dual and multi-slope A/D converters.

UNIT V: **CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs** & **SEQUENTIAL CIRCUITS USING TTL 74XX ICs**	**Transistor-Transistor logic (TTL):** Two-input TTL NAND gate – open-collector gates – Tri-state TTL – TTL subfamilies **CMOS LOGIC:** CMOS inverter – CMOS NAND, NOR gate, Buffered, unbuffered, transmission gate – interfacing – TTL to CMOS – CMOS to TTL **Multiplexers and demultiplexers:** parallel-to-serial data conversion – cascading multiplexer circuits – priority Encoders- cascading decoder circuits. **Flip-Flop**: RS flip-flop, D flip-flop, JK flip-flop. **Shift Registers**: Serial in-serial out, serial in-parallel out- parallel in-serial out, parallel in-parallel out – bidirectional shift register. **Counters**: synchronous, asynchronous counters – binary ripple counter
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Linear Integrated Circuit-D. Roy Choudhury, Shail B. Jain, New Age International Pvt. Ltd., New Delhi, India, 4th edition, 2012. 2. Integrated Electronics, Millman&Halkias, Tata McGraw Hill, 17th Reprint 2000. 3. A Textbook of Electrical technology, B.L. Theraja and A.K. Theraja, S. Chand & Co, 2004. 4. OP-AMP and Linear Integrated Circuits-Ramakant A. Gayakwad, Prentice Hall / Pearson Education, New Delhi, 4th edition, 2012. 5. Digital Electronics: Principles, Devices and Applications, Anil K. Maini, John Wiley & Sons, 2007. 6. Fundamentals of Digital circuits, A. Anand Kumar, PHI learning private Ltd, Delhi, 3rd edition.
REFERENCE BOOKS	1. Design with operational amplifiers and analog integrated circuits Sergio Franco, McGraw Hill, New Delhi. 1997. 2. Analysis and Design of Analog Integrated Circuits, Gray, Meyer, Wiley International, New Delhi. 1995. 3. Digital Principles and Applications Malvino and Leach Tata ,McGraw Hill, New Delhi,5th Edition, 2005 4. Digital Fundamentals -Floyd, Jain, Pearson Education, New Delhi, 8th edition 2009. 5. Principles of Electronics, V.K. Mehta and Rohit Mehta, S. Chand & Co, 12th Edition, 2008.
Tutorial	Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Application (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding), Lock-in detector, box-car integrator

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and op-amp to develops skill to solve problems	**K1 K2 K3 K4 K5 K6**
CO2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	
CO3	Gain knowledge about active filters, PLL, timers and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	
CO4	Learn about various techniques to develop A/D and D/A converters.	
CO5	Acquire the knowledge about the TTL & CMOS logic, combinational and sequential circuits	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	3	2
CO2	3	3	3	3	1
CO3	3	3	3	3	1
CO4	3	3	3	3	1
CO5	3	3	3	2	1

ELECTIVE - LIST 1 -2.PHYSICS OF NANOSCIENCE AND TECHNOLOGY

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E02	**PHYSICS OF NANOSCIENCE AND TECHNOLOGY**	Elective	4	1	0	3	5	75

Learning Objectives

- Physics of nanoscience and technology is concerned with the study, creation, manipulation and applications at nanometer scale.
- To provide the basic knowledge about nanoscience and technology.
- To learn the structures and properties of nanomaterials.
- To acquire the knowledge about synthesis methods and characterization techniques and its applications.
- To apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices

UNITS	Course Details
UNIT I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY	Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of nanomaterials – Metal and Semiconductor nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.
UNIT II: PROPERTIES OF NANOMATERIALS	Physical properties of nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).
UNIT III: SYNTHESIS AND FABRICATION	Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nanomanipulator.
UNIT IV: CHARACTERIZATIO N TECHNIQUES	Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - EDAX analysis - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.
UNIT V: APPLICATIONS OF NANOMATERIALS	Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters –Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries -supercapacitors-photovoltaics.

Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. A textbook of Nanoscience and Nanotechnology, T. Pradeep, Tata McGraw-Hill Publishing, 2012. 2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., 2010. 3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, 2012. 4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, 2002. 5. Nanotechnology and Nanoelectronics, D.P. Kothari, V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt. Ltd, New Delhi, 2018.
REFERENCE BOOKS	1. Nanostructures and Nanomaterials – HuozhongGao – Imperial College Press, 2004. 2. Richard Booker and Earl Boysen, Nanotechnology, Wiley Publishing Inc. USA, 2005. 3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons, 2007. 4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press, 2012. 5. 5. The Nanoscope Encyclopedia of Nanoscience and Nanotechnology, ParagDiwan and AshishBharadwaj, Pentagon Press, New Delhi, 2005.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	**K1 K2 K3 K4 K5 K6**
CO2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	
CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	
CO4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	
CO5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	1	1
CO2	3	3	3	1	1
CO3	3	3	2	1	1
CO4	3	3	3	1	1
CO5	3	3	2	1	1

ELECTIVE - LIST 1 – 3. ENERGY PHYSICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E03	**ENERGY PHYSICS**	Elective	4	1	0	3	5	75

Learning Objectives

- To learn about various renewable energy sources.
- To know the ways of effectively utilizing the oceanic energy.
- To study the method of harnessing wind energy and its advantages.
- To learn the techniques useful for the conversion of biomass into useful energy.
- To know about utilization of solar energy.

UNITS	Course Details
UNIT I: INTRODUCTION TO ENERGY SOURCES	Conventional and non-conventional energy sources and their availability–Prospects of Renewable energy sources– Energy from other sources–chemical energy–Nuclear energy– Energy storage and distribution.
UNIT II: ENERGY FROM THE OCEANS	Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidal energy – Principle of ocean thermal energy conversion systems.
UNIT III: WIND ENERGY SOURCES	Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy.
UNIT IV: ENERGY FROM BIOMASS	Biomass conversion Technologies– wet and dry process– Photosynthesis -Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion–factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas-utilization of biogas.
UNIT V: SOLAR ENERGY SOURCES	Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Non – convention energy sources, G. D. Rai, Khanna publishers, 5th edition, 1998. 2. Energy technology, S. Rao and Dr. ParuLekar, Khanna publishers, 3rd edition, 1994. 3. Solar Energy, M.P. Agarwal, S. Chand and Co,1983. 4. Solar energy, principles of thermal collection and storage, S. P. Sukhatme, Tata McGraw-Hill Publishing Co. Lt., 2nd edition, 1997. 5. Energy Technology, S. Rao and Dr. Parulekar, Khanna publishers, 3rd edition, 1994.
REFERENCE BOOKS	1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, 3rd Edition, 2015. 2. Applied solar energy, A. B. Meinel and A. P. Meinal,Addison-Wesley Publishing Company, 1977. 3. Renewal Energy Technologies: A Practical Guide for Beginners, C.S. Solanki, PHI Learning, 2008. 4. Introduction to Non-Conventional Energy Resources, A.K.Rajaet. al., Sci. Tech Publications, 2015.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Identify various forms of renewable and non-renewable energy sources	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	
CO3	Discuss the working of a windmill and analyze the advantages of wind energy.	
CO4	Distinguish aerobic digestion process from anaerobic digestion.	
CO5	Understand the components of solar radiation, their measurement and apply them to utilize solar energy.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	3	2
CO2	2	3	3	3	2
CO3	2	3	3	3	2
CO4	2	3	3	3	2
CO5	2	3	3	3	2

ELECTIVE - LIST 1 – 4. CRYSTAL GROWTH AND THIN FILMS								
Course Code	**Name of the course**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
25UPPHY1E04	**CRYSTAL GROWTH AND THIN FILMS**	Elective	4	1	0	3	5	75

Learning Objectives
➢ To acquire the knowledge on Nucleation and Kinetics of crystal growth ➢ To understand the Crystallization Principles and Growth techniques ➢ To study various methods of Crystal growth techniques ➢ To understand the thin film deposition methods ➢ To apply the techniques for the Characterization of materials

UNITS	**Course Details**
UNIT I: CRYSTAL GROWTH KINETICS	Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium – Saturation and Super saturation - Gibbs - Thomson equation of vapour and solution - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - rate of Nucleation - Growth mechanism and classification – Importance of crystal growth - epitaxial growth - Kinetics of growth of epitaxial films
UNIT II: CRYSTALLIZATION PRINCIPLES and Solution Growth	Crystallization Principles - Solvents and solutions – Miers Solubility diagram - Super solubility - Expression for super saturation - Metastable zone and introduction period - Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods – Temperature gradient method – Flux growth – Hydrothermal growth.
UNIT III: GEL, MELT AND VAPOUR GROWTH	Gel, Melt growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel – Single and Double diffusion method - Melt techniques – Seed preparation - Czochralski growth - Floating zone - Bridgeman method.
UNIT IV: THIN FILM DEPOSITION METHODS	Thin film deposition methods of thin film preparation – Physical Vapour deposition methods - Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.
UNIT V: CHARACTERIZATION TECHNIQUES	X–ray diffraction – Powder and single crystal – Fourier transform infrared analysis – UV-Vis-NIR spectrometer – Photoluminescence TG /DTA Thermal analysis - Vickers micro hardness - Nonlinear Optical phenomenon (qualitative) - Kurtz powder SHG method – Z-Scan method.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	**1**. Crystal Growth for Beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy, V. Markov, 2nd edition, 2004 2. Thin Film Fundamentals, A. Goswami, New Age, New Delhi, 2008 3. Modeling of Crystal Growth Rates from Solution, M. Ohora and R. C. Reid, 1973 4. Crystal Growth from High Temperature Solution, D. Elwell and H. J. Scheel, 1976 5. Crystal Growth in Gels, Heinz K. Henish, Cambridge University Press, USA, 1973
REFERENCE BOOKS	1. Crystal Growth Process, J.C. Brice, John Wiley, New York, 1986 2. UGC Summer School Notes, P. Ramasamy and F. D. Gnanam, 1983 3. Crystal Growth Processes, P. SanthanaRaghavan and P. Ramasamy, KRU Publications, 2000 4. Crystal Growth, H.E. Buckley, John Wiley and Sons, New York, 1951 5. Crystal Growth, B.R. Pamplin, Pergamon Press, London, 2nd edition 2013

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	**K1**
CO2	Understand the Crystallization Principles and Growth techniques	**K2**
CO3	Study various methods of Crystal growth techniques	**K3**
CO4	Understand the Thin film deposition methods	**K4**
CO5	Apply the techniques to understand the properties of the materials	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	1	2	1
CO2	3	3	1	3	1
CO3	3	2	1	3	1
CO4	3	2	1	2	1
CO5	2	3	3	3	1

ELECTIVE - LIST 1 – 5. ANALYSIS OF CRYSTAL STRUCTURES

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E05	**ANALYSIS OF CRYSTAL STRUCTURES**	Elective	4	1	0	3	5	75

Learning Objectives

- To teach the concept of crystal structures and symmetry, and diffraction theory
- To provide students with a background to X-ray generation, scattering theory and experimental diffraction from single crystals
- To provide instruction on the methods and basis for determining low-molecular weight crystal structures using X-ray Crystallography
- To give the students a background to the instrumentation used for powder diffraction and structure refinement using Rietveld method
- To teach the different levels of structure exhibited by proteins and nucleic acids and methods used in protein crystallography.

UNITS	Course details
UNIT I: CRYSTAL LATTICE	Unit cell and Bravais lattices - Crystal planes and directions - Basic symmetry elements operations - Translational symmetries – Crystal System - Point groups - Space groups - Equivalent positions - Bragg's law - Reciprocal lattice concept -Laue conditions - Ewald and limiting spheres - Diffraction symmetry - Laue groups.
UNIT II: DIFFRACTION	Interaction of X-rays with matter - X-ray generation & detection - Sealed tube, rotating anode, absorption - Filters and monochromators Atomic scattering factor - Fourier transformation and structure factor - Anomalous dispersion - Interpretation of diffraction patterns - Cell parameter determination - Systematic absences - Space group determination.
UNIT III: STRUCTURE ANALYSIS	Single crystal diffractometers - Geometries - Scan modes - Intensity data collection - Data reduction - Factors affecting X-ray intensities - Temperature and scale factor - Electron density - Phase problem - normalized structure factor - Direct method fundamentals and procedures -Patterson function and heavy atom method - Structure refinement - Least squares method - Fourier and difference Fourier synthesis - R factor - structure interpretation - Geometric calculations.
UNIT IV: POWDER METHODS	Fundamentals of powder diffraction – Diffraction theory and diffractometer - Debye Scherrer method - diffractometer geometries - sample preparation and data collection - Identification of unknowns - powder diffraction files (ICDD) - Rietveld refinement fundamentals - Profile analysis - Peak shapes - Whole pattern fitting - Structure refinement procedures – Auto-indexing – Structure determination from powder data - crystallite size determination - Residual stress analysis.
UNIT V: PROTEIN CRYSTALLOGRAPHY	Globular and fibrous proteins, nucleic acids - Primary, secondary, tertiary and quaternary structures - Helical and sheet structures - Ramachandran map and its significance – Crystallization methods

	for proteins - Factors affecting protein crystallization - Heavy atom derivatives – Methods used to solve protein structures - Anomalous dispersion methods.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.
TEXT BOOKS	1. Elements of X-Ray Crystallography, L.V. Azaroff, Techbooksl, New York, 1992. 2. Protein Crystallography, T.L. Blundell and L. Johnson, Academic Press, New York, 1986. 3. Elements of X-ray Diffraction, B.D. Cullity and S.R. Stock, Pearson, 2014. 4. Introduction to Crystal Growth: Principles and Practice, H.L. Bhat, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2015. 5. Crystal Growth, B.R. Pamplin, Pergamon Press, Oxford, 1975.
REFERENCE BOOKS	1. Crystal Structure Analysis: A Primer, J.P. Glusker and K.N. Trueblood, Oxford University Press, New York, 1994. 2. Structure Determination by X-ray Crystallography, M.F.C. Ladd and R.A. Palmer, Plenum Press, New York, 5th Edition, 2014. 3. X-ray Structure Determination, A Practical Guide, G.H. Stout and L. Jensen, Macmillan, New York, 1989. 4. An Introduction to X-ray Crystallography, M.M. Woolfson, Cambridge University Press, New York, 1997. 5. Materials Characterization Techniques, Sam Zhang, Lin Ki, Ashok Kumar, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2009.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Understand crystal symmetry and reciprocal lattice concept for X-ray diffraction	**K1 K2 K3 K4 K5 K6**
CO2	Gain a working knowledge of X-ray generation, X-ray photography with Laue, oscillation and moving film methods, and space group determination	
CO3	Get an exposure to crystal structure determination using program packages	
CO4	Understand the instrumentation used for powder diffraction, data collection, data interpretation, and structure refinement using Rietveld method	
CO5	Get an insight into the structural aspects of proteins and nucleic acids, crystallization of proteins and methods to solve protein structures	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	3
CO2	3	3	3	2	2
CO3	3	3	2	2	2
CO4	3	2	2	2	2
CO5	3	2	2	2	2

ELECTIVE - LIST 1 – 6. MATERIALS SCIENCE

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E06	**MATERIALS SCIENCE**	Elective	4	1	0	3	5	75

Learning Objectives
➢ To gain knowledge on optoelectronic materials ➢ To learn about ceramic processing and advanced ceramics ➢ To understand the processing and applications of polymeric materials ➢ To gain knowledge on the fabrication of composite materials ➢ To learn about shape memory alloys, metallic glasses and nanomaterials

UNITS	Course details
UNIT I: OPTOELECTRONIC MATERIALS	Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission-, loss and gain – quasi Fermi level and recombination. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.
UNIT II CERAMIC MATERIALS	Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, almina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics
UNIT III POLYMERIC MATERIALS	Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – applications: conducting polymers, biopolymers and high temperature polymers.
UNIT IV COMPOSITE MATERIALS	Particle reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications – Graphene based composites.
UNIT V: NEW MATERIALS	Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudo-elasticity, examples and applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - Nano crystalline materials, single walled and multi walled carbon nanotubes
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Electronic and Optoelectronic Properties of Semiconductor Structures, Jasprit Singh, Cambridge University Press, 2007 2. Fiber-Reinforced Composites, P. K. Mallick, CRC Press, 2008 3. Materials Science and Engineering, V. Raghavan, 4th Edition, Prentice-Hall India, New Delhi, 2003 4. Materials Science, G.K. Narula, K.S. Narula, and V.K. Gupta, Tata McGraw-Hill, 1988 5. Materials Science, M. Arumugam, 3rd revised Edition, Anuratha Agencies, 2002
REFERENCE BOOKS	1. Textbook of Nanoscience and Nanotechnology, B. S. Murty, P. Shankar, B. Raj, B. B. Rath, and J. Murday, Springer-Verlag, 2012. 2. Shape Memory and Super Elastic Alloys: Technologies and Applications, K. Yamauchi, I. Ohkata, K. Tsuchiya, and S. Miyazaki (Eds), Woodhead Publishing Limited, 2011. 3. Elements of Materials Science and Engineering, Lawrence H. Van Vlack, 6th Edition, Second ISE reprint, Addison-Wesley, 1998. 4. Solid State Physics – An Introduction to Principles of Materials Science, H. Iabch and H. Luth, 2nd Edition, Springer, 2002. 5. An Introduction to Composite Materials, D. Hull & T. W. Clyne, Cambridge University Press, 3rd edition 2019.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Acquire knowledge on optoelectronic materials	**K1 K2 K3 K4 K5 K6**
CO2	Be able to prepare ceramic materials	
CO3	Be able to understand the processing and applications of polymeric materials	
CO4	Be aware of the fabrication of composite materials	
CO5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	2	2
CO2	2	3	3	2	2
CO3	2	3	2	2	2
CO4	1	3	2	3	2
CO5	2	3	2	2	2

ELECTIVE - LIST 1 – 7. DIGITAL COMMUNICATION

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E07	**DIGITAL COMMUNICATION**	Elective	4	1	0	3	5	75

Learning Objectives
➢ To understand the use of Fourier, transform in analyzing the signals ➢ To learn about the quanta of transmission of information ➢ To make students familiar with different types of pulse modulation ➢ To have an in depth knowledge about the various methods of error controlling codes ➢ To acquire knowledge about spread spectrum techniques in getting secured communication

UNITS	Course Details
UNIT I: SIGNAL ANALYSIS	Fourier transforms of gate functions, delta functions at the origin – Two delta function and periodic delta function – Properties of Fourier transform – Frequency shifting –Time shifting - Convolution –Graphical representation – Convolution theorem – Time Convolution theorem –Frequency Convolution theorem –Sampling theorem.
UNIT II: INFORMATION THEORY	Communication system – Measurement of information – Coding – Bandot Code CCITT Code –Hartley Law – Noise in an information Carrying Channel- Effects of noise- Capacity of noise in a channel – Shannon Hartley theorem –Redundancy.
UNIT III: PULSE MODULATION	Pulse amplitude modulation - natural sampling – Instantaneous sampling - Transmission of PAM Signals -Pulse width modulation – Time division multiplexing – Band width requirements for PAM Signals. Pulse Code Modulation –Principles of PCM –Quantizing noise – Generation and demodulation of PCM -Effects of noise –Companding – Advantages and application
UNIT IV: ERROR CONTROL CODING	Introduction to Linear Block Codes, Hamming Codes, BCH Coding, RS Coding, Convolutional Coding, Coding Grain Viterbi Coding
UNIT V: SPREAD SPECTRUM SYSTEMS	Pseudo Noise sequences, generation and Correlation properties, direct sequence spread spectrum systems, frequency HOP Systems, processing gain, anti-jam and multipath performance
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Communication system, B.P. Lathi, Wiley Eastern, 1964. 2. Electronic Communication Systems, George Kennedy, McGraw Hill, 3rd Edition,2009. 3. Simon Haykin, Communication System, 3rd Edition, John Wiley & Sons,2008. 4. Electronic Communication System, George Kennedy and Davis, Tata McGraw Hill, 4th Edition, 1988 5. "Principles of Communication System", Taub and Schilling, Tata McGraw Hill, Second edition, 1991.
REFERENCE BOOKS	1. Digital Communication, John Proakis, McGraw Hill, Malaysia, 3rd Edition,1995. 2. Digital Communication Techniques, Signal Design and Detection, M. K. Simen, Prentice Hall of India, 1999. 3. Electronics communications, Dennis Roddy and Coolen, Prentice Hall of India IV Edition, 1995. 4. Advanced Electronics communication System, Wave Tomasi, Prentice Hall, Inc, 4thEdition, 1998. 5. Microwave and Radar Engineering, Kulkarni, Umesh Publications, 1988.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Apply the techniques of Fourier transform, convolution and sampling theorems in signal processing	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Apply different information theories in the process of study of coding of information, storage and communication	
CO3	Explain and compare the various methods of pulse modulation techniques	
CO4	Apply the error control coding techniques in detecting and correcting errors-able to discuss, analyze and compare the different error control coding	
CO5	Apply, discuss and compare the spread spectrum techniques for secure communications	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	1	2
CO2	3	3	3	1	2
CO3	3	3	3	1	2
CO4	3	3	3	1	2
CO5	3	3	3	1	2

ELECTIVE LIST 1 – 8. COMMUNICATION ELECTRONICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E08	**COMMUNICATION ELECTRONICS**	Elective	4	1	0	3	5	75

Learning Objectives

- To comprehend the transmission of electromagnetic waves thorough different types of antenna and also to acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth
- To gain knowledge in the generation and propagation of microwaves
- To acquire knowledge about radar systems and its applications and also the working principle of colour television
- To learn the working principle of fiber optics and its use in telecommunication
- To understand the general theory and operation of satellite communication systems

UNITS	Course Details
UNIT I: ANTENNAS AND WAVE PROPAGATION	Radiation field and radiation resistance of short dipole antenna-grounded antenna-ungrounded antenna-antenna arrays-broadside and end side arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere- Ecles and Larmor theory- Magnento ionic theory-ground wave propagation
UNIT II: MICROWAVES	Microwave generation—multi cavity Klystron-reflex klystron-magnetron travelling wave tubes (TWT) and other microwave tubes-MASER-Gunn diode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio(SWR)
UNIT III: RADAR AND TELEVISION	Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers-radar receivers and indicators-pulsed systems-other radar systems- colour TV transmission and reception-colour mixing principle-colour picture tubes- Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV
UNIT IV: OPTICAL FIBER	Propagation of light in an optical fibre-acceptance angle-numerical aperture-step and graded index fibres-optical fibres as a cylindrical wave guide-wave guide equations-wave guide equations in step index fibres - fibre losses and dispersion-applications
UNIT V: SATELLITE COMMUNICATION	Orbital satellites-geostationary satellites-orbital patterns-satellite system link models-satellite system parameters-satellite system link equation link budget-INSAT communication satellites

Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Handbook of Electronics, Gupta and Kumar, 2008 edition. 2. Electronic communication systems, George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988. 3. Taub and Schilling, principles of communication systems, Tata McGraw Hill second edition (1991). 4. Microwave and radar engineering, M. Kulkarani, Umesh Publications, 1998. 5. Mono Chrome and colour television, R. R. Ghulathi,1999.
REFERENCE BOOKS	1. Electronic communications – Dennis Roody and Coolen, Prentice Hall of India, IV edition, 1995. 2. Advanced electronics communication systems, Wayne Tomasi, Prentice Hall of India, fourth edition, 1998 3. Electronics communications, Dennis Roddy and Coolen, Prentice Hall of India IV Edition, 1995. 4. "Advanced Electronics communication System" Wayne Tomasi, 4th edition, Prentice Hall of India, 1998 5. Electronic Devices and Circuits, S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition, 2009.

COURSE OUTCOMES:
At the end of the course, the student will be able to:

CO 1	Discuss and compare the propagation of electromagnetic waves through sky and on earth's surface Evaluate the energy and power radiated by the different types of antenna	**K1 K2 K3 K4 K5 K6**
CO 2	Compare and differentiate the methods of generation of microwaves analyze the propagation of microwaves through wave guides- discuss and compare the different methods of generation of microwaves	
CO 3	Classify and compare the working of different radar systems- apply the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances – discuss the importance of radar in military- elaborate and compare the working of different picture tube	
CO 4	Classify, discuss and compare the different types of optical fiber and also to justify the need of it-discover the use of optical fiber as wave guide	
CO5	Explain the importance of satellite communication in our daily life-distinguish between orbital and geostationary satellites elaborate the linking of satellites with ground station on the earth	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes (CO) for each course with program outcomes (PO) in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1).

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	1	2
CO2	3	3	3	1	2
CO3	3	3	3	1	2
CO4	3	3	3	1	2
CO5	3	3	3	1	2

ELECTIVE - LIST 2 – 9. MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E09	**MICROPROCESSOR 8085 AND MICROCONTROLLER 8051**	Elective	4	1	0	3	5	75

Learning Objectives

- To provide an understanding of the architecture and functioning of microprocessor 8085 and to write the assembly language programs.
- To introduce 8085 programming and applications and to the methods of interfacing I/O devices and memory to microprocessor.
- To know the architecture aspects of Microcontrollers.
- To write assembly language programs of Microcontroller for various applications.
- To know the importance of different peripheral device and their interfacing to Microcontrollers.

UNITS	Course Details
UNIT I: INTRODUCTION TO 8085	Introduction – Architecture of 8085 – pin configurations of 8085 – Interrupt structure and operation – Instruction set of 8085 – data transfer – arithmetic -logical -branching – stack, I/O and machine control operations – opcode formats – Addressing modes in 8085 – assembly language programming- Programs (arithmetic operations of 8-bit &16-bit numbers) – Programming techniques – looping, counting, indexing.
UNIT II: 8085 PROGRAMMING, PERIPHERAL DEVICES AND THEIR INTERFACING APPLICATIONS	Interfacing D/A & A/D – binary weighted resistors – R/2R ladder network - successive approximation – Seven segment LED interface (8155) – square wave generator using 8155 timer – 8255A programmable peripheral interface (PPI) – 8254 programmable interval timer – 8259A interrupt controller – priority modes – interfacing matrix keyboard – stepper motor
UNIT III: 8051 MICROCONTROLLER HARDWARE	Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/ Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory.
UNIT IV: 8051 INSTRUCTIONS SET AND ASSEMBLY LANGUAGE PROGRAMMING	Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.

UNIT V: INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD	8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051: Nested interrupts, Software triggering of interrupt. LED Interface Seven segment display interface- Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface – interfacing LCD displays.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Microprocessors, A. P. Godse and D. A. Godse, Technical Publications, Pune 2009. 2. Microprocessor Architecture, Programming and Applications with 8085, Ramesh GaonkarPenram International Publishing 2013. 3. Microprocessors & Microcontrollers, A. NagoorKani, RBA Publications 2009 4. Fundamentals of Microprocessors & Microcontrollers, B. Ram, DhanpatRai publications New Delhi 2016. 5. Fundamentals of Microprocessor-8085‖, V. Vijayendran, S.VisvanathanPvt, Ltd. 3rd Edition, 2005.
REFERENCE BOOKS	1. Microprocessors and Interfacing programming and Hardware, Douglas V. Hall, Tata McGraw Hill Publications 2008 2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education 2008. 3. The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, Barry B. Brey, Prentice- Hall of India, New Delhi, 3rd Edition 1995. 4. "The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications", J. Uffrenbeck, Prentice-Hall of India, New Delhi 1985. 5. "The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications", W. A. Tribel, Avtar Singh, Prentice-Hall of India, New Delhi,2006.
TUTORIALS	Microprocessor and micro-controller basics

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO 1	Gain knowledge of architecture and working of 8085 microprocessors.	**K1 K2 K3 K4 K5 K6**
CO 2	Get knowledge of architecture and working of 8051 Microcontroller.	
CO 3	Be able to write simple assembly language programs for 8085A microprocessor.	
CO 4	Able to write simple assembly language programs for 8051 Microcontroller.	
CO 5	Understand the different applications of microprocessor and microcontroller.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	3	3
CO2	2	1	1	1	1
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

ELECTIVE - LIST 2 – 10. PLASMA PHYSICS

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E10	**PLASMA PHYSICS**	Elective	4	1	0	3	5	75

Learning Objectives
➢ To study the fundamental concepts of Plasma ➢ To learn the behavior in magnetic field ➢ To understand the model plasma phenomena in the universe. ➢ To explore the plasma universe by means of in-site and ground-based observations. ➢ To explore the physical processes which occur in the space environment

UNITS	Course Details
UNIT I: FUNDAMENTAL CONCEPTS OF PLASMA	Kinetic pressure in a partially ionized - mean free path and collision cross section - Mobility of charged particles - Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity-Effect of magnetic field- Quasi- neutrality of plasma Debye shielding distance - Optical properties of plasma – Debye length – AC conductivity & DC conductivity.
UNIT II: MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELD	Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and magnetic fields-Motion of charged particle inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement - motion of an electron in a time varying electric field- Magneto- hydrodynamics - Magneto-hydrodynamic equations – Condition for magneto hydrodynamic behaviour.
UNIT III: PLASMA OSCILLATIONS AND WAVES	Introduction, theory of simple oscillations - electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation - Ion oscillation and waves in a magnetic field - thermal effects on plasma oscillations - Landau damping - Hydro magnetic waves - Oscillations in an electron beam.
UNIT IV: PLASMA DIAGNOSTICS TECHNIQUES	Single probe method - Double probe method - Use of probe technique for measurement of plasma parameters in magnetic field - microwave method - spectroscopic method - -laser as a tool for plasma diagnostics-X-ray diagnostics of plasma - acoustic method - conclusion.
UNIT V: APPLICATIONS OF PLASMA PHYSICS	Magneto hydrodynamic Generator - Basic theory - Principle of Working-Fuel in MHD Generator - Generation of Microwaves Utilizing High Density Plasma - Plasma Diode – Laser driven fusion, laser ablation.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

paper)	
TEXT BOOKS	1. Introduction to Electrodynamics – David J. Griffiths, 4th Edition, Pearson, 2012. 2. Electromagnetic Theory and Electrodynamics –Sathya Prakash, Kedar Nath Ram Nath and Co, 2017. 3. Electromagnetics - B.B Laud, Wiley Eastern Company, 2000. 4. Fundamentals of Electromagnetic -WazedMiah, Tata McGraw Hill, 1980. 5. Basic Electromagnetics with Application - Narayanarao, (EEE) Prentice Hall, 1997.
REFERENCE BOOKS	1. Fundamentals of Electromagnetic Theory – John R.Reitz, Frederick J Milford and Robert W.Christy, 3rd edition, Narosa Publishing House, New Delhi, 1998. 2. Classical Electrodynamics – by Deraad lester, L. Milton, 2019. 3. Advanced Engineering electromagnetics – Nathan ida, 3rd Edition 2024. 4. Electromagnetics, B.B Laud, Wiley Eastern Company, 2000.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Understand the plasma and learn the magneto-hydrodynamics concepts applied to plasma.	
CO3	Explore the oscillations and waves of charged particles and thereby apply the Maxwell's equation to quantitative analysis of plasma.	
CO4	Analyze the different principle and techniques to diagnostics of plasma.	
CO5	Learn the possible applications of plasma by incorporating various electrical and electronic instruments.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	3	2	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2

ELECTIVE - LIST 2 – 11. BIO PHYSICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E11	BIOPHYSICS	Elective	4	1	0	3	5	75

Learning Objectives

- To understand the physical principles involved in cell function maintenance.
- To understand the fundamentals of macromolecular structures involved in propagation of life.
- To understand the biophysical function of membrane and neuron.
- To understand various kinds of radiation and their effects on living system and to know the hazards posed by such radiations and the required precautions.
- To understand the physical principles behind the various techniques available for interrogating biological macromolecules.

UNITS	Course Details
UNIT I: CELLULAR BIOPHYSICS	Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells.
UNIT II: MOLECULAR BIOPHYSICS	Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation. Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.
UNIT III: MEMBRANE AND NEURO BIOPHYISCS	Models membranes - Biological membranes and dynamics – Membrane Capacitors – Transport across cell and organelle membranes – Ion channels. Nervous system: Organization of the nervous system –Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation.
UNIT IV: RADIATION BIO PHYSICS	X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer.
UNIT V: PHYSICAL METHODS IN BIOLOGY	Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.

Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. The cell: A molecular approach-Geoffrey M. Cooper, Oxford university Press, 2023 9th edition. 2. Biophysics- VasanthaPattabhi, N. Gautham, Springer Netherlands, 2014 3. Biophysics- P. S. Mishra VK Enterprises, 2010. 4. Biophysics- M. A Subramanian, MJP Publishers, 2005. 5. Bioinstrumentation-L. Veerakumari, MJP Publishers, 2006.
REFERENCE BOOKS	1. Chemical Biophysics- Daniel A.Beard,Cambridge University Press, 2008. 2. Essential cell biology -Bruce Albert et al.,Garland Science. 3. Biophysics- W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin,1983. 4. Membrane Biophysics - Mohammad Ashrafuzzaman, Jack A. Tuszynski, Springer science & business media. 5. Biological spectroscopy-Iain D. Campbell, Raymond A. Dwek

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the structural organization and function of living cells and should able to apply the cell signaling mechanism and its electrical activities.	**K1 K2 K3 K4 K5 K6**
CO2	Comprehension of the role of biomolecular conformation to function.	
CO3	Conceptual understanding of the function of biological membranes and also to understand the functioning of nervous system.	
CO4	To know the effects of various radiations on living systems and how to prevent ill effects of radiations.	
CO5	Analyze and interpret data from various techniques viz., spectroscopy, crystallography, chromatography etc.,	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	2
CO2	3	3	3	2	2
CO3	3	3	3	3	3
CO4	3	3	3	2	2
CO5	3	3	3	3	2

ELECTIVE - LIST 2 – 12. NON-LINEAR DYNAMICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E12	**NONLINEAR DYNAMICS**	Elective	4	1	0	3	5	75

Learning Objectives

- To edifice the students about the analytical and numerical techniques of nonlinear dynamics.
- To make the students understand the concepts of various coherent structures.
- To train the students on bifurcations and onset of chaos.
- To educate the students about the theory of chaos and its characterization.
- To make the students aware of the applications of solitons, chaos and fractals.

UNITS	Course Details
UNIT - I: GENERAL	Linear waves-ordinary differential equations (ODEs)-Partial differential equations (PDEs)- Methods to solve ODEs and PDEs.- Numerical methods – Linear and Nonlinear oscillators-Nonlinear waves - Qualitative features
UNIT - II: COHERENT STRUCTURES	Linear and Nonlinear dispersive waves - Solitons – KdB equation – Basic theory of KdB equation – Ubiquitous soliton equations – AKNS Method, Backlund transformation, Hirotabilinearization method, Painleve analysis - Perturbation methods- Solitons in Optical fibres - Applications.
UNIT - III: BIFURCATIONS AND ONSET OF CHAOS	One dimensional flows – Two dimensional flows – Phase plane – Limit cycles – Simple bifurcations – Discrete Dynamical system – Strange attractors – Routes to chaos.
UNIT - IV FRACTALS AND STRANGE ATTRACTORS	Fractals : examples, similarity dimension and box dimension; Rayleigh-Benard convection : basic equations, Boussinesq approximation; Lorenz map : Stability of fixed points and appearance of strange attractors; Baker's map; Henon map : relation with periodically kicked rotator, stability of fixed points and appearance of strange attractors.
UNIT - V APPLICATIONS	Soliton based communication systems – Solition based computation – Synchronization of chaos – Chaos based communication – Cryptography – Image processing – Stochastic – Resonance – Chaos based computation – Time Series analysis.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.

TEXT BOOKS	1. Nonlinear Dynamics: Integrability, Chaos and Patterns, M. Lakshmanan and S. Rajasekar, Springer, 2003. 2. Solitons in Optical Communications, A. Hasegawa and Y. Kodama, Oxford Press, 1995. 3. Nonlinear Systems, P. G. Drazin, Cambridge University Press, 2012. ISBN: 9781139172455. 4. Introduction to Applied Nonlinear Dynamical Systems and Chaos, S. Wiggins, Springer, 2003. ISBN: 9780387001777. 5. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, Strogatz, Steven H. Westview Press, 2014. ISBN: 9780813349107.
REFERENCE BOOKS	1. Solitons: An Introduction, G. Drazin and R. S. Johnson, Cambridge University Press, 1989. 2. Chaos in Nonlinear Oscillators, M. Lakshmanan and K. Murali, World Scientific, 1989. 3. Nonlinear Dynamics and Chaos, S. Strogatz, Addison Wesley, 1995. 4. Chaos, HaoBai-Lin, World Scientidic, Singapore, 1984. 5. Mathematical Methods for Scientists & Engineers, P.B. Kahn, Wiley, NY, 1990.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Gain knowledge about the available analytical and numerical methods to solve various nonlinear systems.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Understand the concepts of different types of coherent structures and their importance in science and technology.	
CO3	Learn about simple and complex bifurcations and the routes to chaos	
CO4	Acquire knowledge about various oscillators, characterization of chaos and fractals.	
CO5	To analyze and evaluate the applications of solutions in telecommunication, applications of chaos in cryptography, computations and that of fractals.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	3
CO2	3	2	2	2	3
CO3	2	2	2	2	2
CO4	2	2	2	2	2
CO5	1	2	2	2	1

ELECTIVE - LIST – 2. 13. QUANTUM FIELD THEORY

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E13	**QUANTUM FIELD THEORY**	Elective	4	1	0	3	5	75

Learning Objectives

- To school the students about the analytical and numerical techniques of nonlinear dynamics.
- To make the students understand the concepts of various coherent structures.
- To train the students on bifurcations and onset of chaos.
- To educate the students about the theory of chaos and its characterization.
- To make the students aware of the applications of solitons, chaos and fractals.

UNITS	Course Details
UNIT I: SYMMETRY PRINCIPLES	Relativistic kinematics, relativistic waves, Klein-Gordon (KG) equation as a relativistic wave equation, treatment of the KG equation as a classical wave equation: itsLagrangianandHamiltonian, Noether's theorem and derivation of energy-momentum and angular momentum tensors as consequence of Poincarésymmetry, internal symmetry and the associated conserved current.
UNIT II: QUANTIZATION OF KLEIN-GORDAN FIELD	Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, definition of the vacuum and N-particle eigenstatesofthe Hamiltonian, vacuum expectation values, propagators, spin and statistics of the KG quantum.
UNIT III: QUANTIZATION OF DIRAC FIELD	Review of Dirac equation and its quantization, use of anti-commutators, creation and destruction operators of particles and antiparticles, Dirac propagator, energy, momentum and angular momentum, spin and statistics of Dirac quanta.
UNIT IV: QUANTIZATION OF ELECTROMAGNETIC FIELDS	Review of free Maxwell's equations, Lagrangian, gauge transformation and gauge fixing, Hamiltonian, quantization in terms of transverse delta functions, expansion in terms of creation operators, spin, statistics and propagator of the photon.
UNIT V: PERTURBATIVE INTERACTION AT TREE LEVEL	Introduction to interacting quantum fields, Wick's Theorem, Feynman Diagram, Examples from quantum electrodynamics at the tree level: positron-electron and electron-electron scattering.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. J. D. BjorkenandS. D. Drell, Relativistic Quantum Fields, McGraw-Hill Book Company, 1965. 2. An Introduction to Quantum Field Theory, M.E. Peskin and D. V. Schroeder, Taylor and Francis, 2018. 3. Quantum Field theory: From Operators to Path Integrals, Kerson Huang, Wiley, 2nd Edition, 2008. 4. Quantum Field Theory, Mark Srednicki, 2006. 5. Quantum Field Theory, Claude Itzykson and Jean Bernard Zuber, Dover, 2006.
REFERENCE BOOKS	1. Quantum Electrodynamics,V. B. Berestetskii, E. M. Lifshitzand L. P. Pitaevskii, Elseveir, 1982. 2. Introduction to Theory of Quantized Fields, N. N. Bogoliubov and D. V. Shirkov, 1959. 3. Quantum Field Theory, L. H. Ryder, Cambridge University Press, 2ndEdition, 1996. 4. Quantum Field Theory, L. S. Brown, Cambridge University Press, 1992. 5. Quantum Field Theory: A Modern Introduction, M. Kaku, Oxford University Press, 1993

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the interconnection of Quantum Mechanics and Special Relativity	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Enable the students to understand the method of quantization to various field	
CO3	Employ the creation and annihilation operators for quantization	
CO4	Summarizes the interacting field, in quantum domain, and gives a discussion on how perturbation theory is used here.	
CO5	Understand the concept of Feynman diagram	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	3	2
CO2	3	3	2	3	3
CO3	3	3	2	3	2
CO4	3	3	2	3	3
CO5	3	3	2	3	3

ELECTIVE - LIST – 2. 14 - GENERAL RELATIVITY AND COSMOLOGY

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E14	**GENERAL RELATIVITY AND COSMOLOGY**	Elective	4	1	0	3	5	75

Learning Objectives

- To give an introduction to students in the areas of general relativity and cosmology
- To understanding of the underlying theoretical aspects of general relativity and cosmology
- To gain knowledge on space time curvature
- To equipped to take up research in cosmology
- To confidently solve problems using mathematical skills

UNITS	Course Details
UNIT I: TENSORS	Tensors in index notation - Kronecker and Levi Civita tensors - inner and outer products - contraction - symmetric and antisymmetric tensors - quotient law - metric tensors - covariant and contravariant tensors - vectors - the tangent space - dual vectors - tensors - tensor products - the Levi-Civita tensor - tensors in Riemann spaces
UNIT I: TENSORS FIELD	Vector-fields, tensor-fields, transformation of tensors - gradient and Laplace operator in general coordinates - covariant derivatives and Christoffel connection - Elasticity: Field tensor - field energy tensor - strain tensor - tensor of elasticity- curvature tensor
UNIT III: GENERAL RELATIVITY	The space time interval - the metric - Lorentz transformations - space-time diagrams - world-lines - proper time - energy-momentum vector - energy-momentum tensor - perfect fluids - energy-momentum conservation - parallel transport - the parallel propagator - geodesics - affine parameters - the Riemann curvature tensor - symmetries of the Riemann tensor - the Bianchi identity
UNIT IV: TENSOR IN RELATIVITY	Ricci and Einstein tensors - Weyl tensor - Killing vectors - the Principle of Equivalence - gravitational redshift - gravitation as space-time curvature - the Newtonian limit - physics in curved space-time - Einstein's equations - the Weak Energy Condition - causality - spherical symmetry - the Schwarzschild metric - perihelion precession

UNIT V: COSMOLOGY	Expansion of the Universe - thermal history - and the standard cosmological model - Friedmann - Robertson-Walker type models of the Universe - Primordial inflation and the theory of cosmological fluctuations - Theory and observations of the cosmic microwave background and of the large-scale structure of the Universe - Dark matter and dark energy - theoretical questions and observational evidence - inflation - origin of galaxies and other open problems
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. M. R. Spiegel, Vector Analysis, Schaum'a outline series, McGraw Hill, New York, 1974. 2. James Hartle, Gravity: An introduction to Einstein's general relativity,San Francisco, Addison-Wesley, 2002. 3. Sean Carroll, Spacetime and Geometry: An Introduction to General Relativity, Addison-Wesley, 2004. 4. Jerzy Plebanskiand AndrzejKrasinski, An Introduction to General Relativity and Cosmology,Cambridge University Press, 2006. 5. Meisner, Thorne and Wheeler: Gravitation W. H. Freeman & Co., San Francisco, 1973.
REFERENCE BOOKS	1. Robert M. Wald: Space, Time, and Gravity: the Theory of the Big Bang and Black Holes, Univ. of Chicago Press, 1992. 2. J. V. Narlikar, Introduction to Cosmology, Jones & Bartlett, 1983. 3. Steven Weinberg, Gravitation and Cosmology, New York, Wiley, 1972. 4. Jerzy Plebanski and AndrzejKrasinski, An Introduction to General Relativity and Cosmology, Cambridge University Press, 2006. 5. R Adler, M Bazin& M Schiffer, Introduction to General Relativity, McGraw Hill Book company, 1975.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Skillfully handle tensors	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Understanding of the underlying theoretical aspects of general relativity and cosmology	
CO3	Gain knowledge on space time curvature	
CO4	Equipped to take up research in cosmology	
CO5	Confidently solve problems using mathematical skills	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	3	2
CO2	3	3	2	3	3
CO3	3	3	2	3	2
CO4	3	3	2	3	3
CO5	3	3	2	3	3

ELECTIVE - LIST 2 – 15. ADVANCED OPTICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E15	**ADVANCED OPTICS**	Elective	4	1	0	3	5	75

Learning Objectives
➢ To know the concepts behind polarization and could pursue research work on application aspects of laser ➢ To impart an extensive understanding of fiber and non-linear optics ➢ To study the working of different types of LASERS ➢ To differentiate first and second harmonic generation ➢ Learn the principles of magneto-optic and electro-optic effects and its applications

UNITS	Course Details
UNIT 1: POLARIZATION AND DOUBLE REFRACTION	Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity
UNIT II: LASERS	Basic principles – Spontaneous and stimulated emissions – Einstein's coefficients - Laser rate equations - Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Nd:YAG laser – dye laser - gas lasers – He-Ne laser – CO_2 laser – Semiconductor laser
UNIT III: FIBER OPTICS	Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Step index and graded index fibers - Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor
UNIT IV: NON-LINEAR OPTICS	Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light
UNIT V: MAGNETO-OPTICS AND ELECTRO-OPTICS	Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect — Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Lasers and Non – Linear Optics, B. B. Laud, 3rd Edition, New Age International (P) Ltd., 2017. 2. Optics, AjoyGhatak, 6th Edition, McGraw – Hill Education Pvt. Ltd, 2017. 3. Laser Fundamentals, William T. Silfvast, Cambridge University Press, New York, 1996. 4. Physics of Light and Optics, Justin Peatross, Michael Ware, Brigham Young University, 2011. 5. B. E. A Saleh, and M.C. Teich, Fundamentals of Photonics, Wiley India Pvt Ltd, 2012.
REFERENCE BOOKS	1. Fundamentals of Optics, F. S. Jenkins and H. E. White, (4th Edition), McGraw – Hill International Edition, 1981. 2. Optics, Light and Lasers, Dieter Meschede, Wiley – VCH, Varley GmbH, 2004. 3. Optical Physics, Lipson, S. G. Lipson and H. Lipson, 4th Edition, Cambridge University Press, New Delhi, 2011. 4. Light and Matter, Y. B. Band, , Wiley and Sons, 2006. 5. Modern Optics, R. Guenther, Wiley and Sons, 1990.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Discuss the transverse character of light waves and different polarization phenomenon	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	
CO3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	
CO4	Identify the properties of nonlinear interactions of light and matter	
CO5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	3
CO2	3	3	3	2	3
CO3	3	3	3	2	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

ELECTIVE - LIST 2 – 16. ADVANCED MATHEMATICAL PHYSICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E16	**ADVANCED MATHEMATICAL PHYSICS**	Elective	3	1	0	3	4	75

Learning Objectives

- To develop knowledge in group theory, special theory of relativity and tensor and its applications.
- To develop expertise in mathematical techniques required in physics.
- To enhance problem solving skills in group theory, special theory of relativity and tensor.
- To enable students to formulate, interpret and draw inferences from mathematical solutions
- To develop skills to apply group theory and tensors to peruse research

UNITS	Course Details
UNIT I: DISCRETE GROUPS	Definition of a group, subgroup, class, Lagrange's theorem, invariant subgroup, Homomorphism and isomorphism between two groups. Representation of a group, unitary representations, reducible and irreducible representations Schur's lemmas, orthogonality theorem, character table, reduction of Kronecker product of representations, criterion for irreducibility of a representation.
UNIT II: CONTINUOUS GROUPS	Infinitesimal generators, Lie algebra; Rotation group, representations of the Lie algebra of the rotation group, representation of the rotation group, D-matrices and their basic properties. Addition of two angular momenta and C.G. coefficients, Wigner-Eckart theorem.
UNIT III: SPECIAL UNITARY GROUPS	Definition of unitary, unimodular groups SU (2) and SU(3). Lie algebra of SU(2). Relation between SU(2) and rotation group. Lie algebra of SU(3)-Gellmann's matrices. Cartan form of the SU(3). Lie algebra, roots and root diagram for SU(3). Weights and their properties, weight diagrams for the irreducible representations 3.3*-, 6,6 8, 10 and 10 of SU(3). Direct product of two SU(3) representations, Young tableaux method of decomposition of products of IR's illustrations with the representations of dim<10. C.G. coefficients for 3 x 3* and 3 x 6 representations. SU(3) symmetry in elementary particle physics, quantum numbers of hadrons and SU(2) and SU(3) classification of hadrons.
UNIT IV: TENSORS	Cartesian vectors and tensors illustration with moment of inertia, conductivity, dielectric tensors. Four vector in special relativitity, vectors and tensors under Lorentz transformations, Illustration from physics. Vectors and tensors under general co-ordinate transformations, contravariant and covariant vectors and tensors, mixed tensors; tensor algebra, addition, subtraction, direct product of tensors, quotient theorem, symmetric and antisymmetric tensors.

UNIT V: TENSOR CALCULUS	Parallel transport, covariant derivative, affine connection. Metric tensor. Expression for Christoffel symbols in terms of and its derivatives (assuming D g = 0. Curvature tensor, Ricci tensor and Einstein tensor. Bianchi identities, Schwarzschild solution to the Einstein equation G=0.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Group Theory for Physicists, A. W. Joshi, New Age International Publishers, Fifth edition, 2018 2. Unitary Symmetry and Elementary Particles, D. B. Lichtenberg, New York : Academic Press, 1978. 3. Mathematical Physics, E. Butkov, Addison-Wesley Publishing Company, 1968. 4. General Relativity &Cosmology,J. V. Narlikar, Macmillan, 1979. 5. Mathematical Physics, R. Geroch, The University of Chicago press, 1985.
REFERENCE BOOKS	1. Group Theory, M. Hamermesh, Dover Publications Inc.; Reprint edition, 2003 2. Elementary Theory of Angular Momentum, M. E. Rose,Dover Publications Inc., New edition, 2003. 3. Georgi : Lie Groups for Physicists, 2019 edition. 4. Tensors, Relativity & Cosmology, E. A. Lord, Tata McGraw-Hill, 1976. 5. A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry, P. Szekeres, Cambridge University Press, 2004

COURSE OUTCOMES:

At the end of the course, the student will be able

CO1	Gain knowledge of both discrete and continuous groups	**K1**
CO2	Apply various important theorems in group theory	**K2**
CO3	Construct group multiplication table, character table relevant to important branches of physics.	**K3** **K4**
CO4	Equip to solve problems in tensors	**K5**
CO5	Develop skills to apply group theory and tensors to peruse research	**K6**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	1	1
CO2	3	3	2	1	1
CO3	3	3	2	1	2
CO4	3	3	2	2	1
CO5	3	3	2	1	1

ELECTIVE - LIST 3 - 17. ADVANCED SPECTROSCOPY

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E17	**ADVANCED SPECTROSCOPY**	Elective	4	1	0	3	5	75

Learning Objectives

- Helps students understand and appreciate spectroscopy as a sufficiently broad field in which many sub disciplines exist.
- To understand the recent advances in laser technology
- Make them appreciate each of these specific techniques with numerous implementations.
- To realize the progress in this field that is rapid, resulting in improved instrument capabilities and an ever-widening range of applications.
- To apply group theory in spectroscopy to shed light on molecular symmetry and determine important physical parameters.

UNITS	Course Details
UNIT I: MOLECULAR SPECTROSCOPY AND GROUP THEORY	Group axioms –subgroup, simple group, Abelian group, cyclic group, order of a group, class- Lagrange's theorem statement and proof - Symmetry operations and symmetry elements - Application: construction of group multiplication table (not character table) for groups of order 2, 3, cyclic group of order 4, noncyclic group of order 4 – reducible and irreducible representations- Unitary representations – Schur's lemmas – Great orthogonality theorem - point group - Simple applications : Symmetry operations of water and ammonia- Construction of character table for C_{2v} (water) and C_{3v} (ammonia) molecules
UNIT II: LASER SPECTROSCOPY	Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission- ultra short pulses- laser cooling -Single and multi-mode lasers- Laser tenability- Fluorescence spectroscopy with lasers- Laser Raman Spectroscopy – Non-linear Spectroscopy – Applications of Laser Spectroscopy in medical fields, materials science research
UNIT III: MOSSBAUER SPECTROSCOPY	Basic idea of Mossbauer spectroscopy - Principle- Mossbauer effect- Recoilless emission and absorption- Chemical shift -Effect of electric and magnetic fields – hyperfine interactions- instrumentation- Applications: understanding molecular and electronic structures
UNIT IV: XRAY PHOTOELECTRON SPECTROSCOPY	Principle – XPS spectra and its interpretation- ECSA-EDAX- other forms of XPS – chemical shift - Applications : - stoichiometric analysis- electronic structure- XPES techniques used in astronomy, glass industries, paints and in biological research
UNIT V: MOLECULAR MODELLING	Determination of force constants- force field from spectroscopic data- normal coordinate analysis of a simple molecule (H_2O) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from spectroscopic data- molecular modelling using data from various spectroscopic studies

Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Organic Spectroscopy, William Kemp, MacMillan, Indian Edition, 3rd Edition, 2019. 2. Fundamentals of Molecular Spectroscopy, C N Banwell and McCash, Tata McGraw–Hill, New Delhi, 4th Edition, 1994. 3. Vibrational Spectroscopy and Applications, D.N. Satyanarayana, New Age International Publication, 2001. 4. Spectroscopy, B.K. Sharma , Goel Publishing House Meerut, 2015 5. Basic Atomic and Molecular Spectroscopy, J M Hollas, Royal Society of Chemistry, RSC, Cambridge, 2002.
REFERENCE BOOKS	1. Molecular Spectroscopy, J L McHale, Pearson Education India, New Delhi, 2008. 2. Basic Atomic and Molecular Spectroscopy, J M Hollas, Royal Society of Chemistry, RSC, Cambridge, 2002. 3. Spectroscopy Vol. I, B. P. Straughan and S. Walker, Chapman and Hall, New York, 1976. 4. Introductory Quantum Chemistry, K. Chandra, Tata McGraw Hill, New Delhi, 1989. 5. Laser Spectroscopy: Basic concepts and Instrumentation, W. Demtroder, Springer Link

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Comprehend set of operations associated with symmetry elements of a molecule, apply mathematical theory while working with symmetry operations.	**K1 K2 K3 K4 K5 K6**
CO2	Align with the recent advances in semiconductor laser technology combined sensitive spectroscopic detection techniques.	
CO3	Understand principle behind Mossbauer spectroscopy and apply the concepts of isomer shift and quadrupole splitting to analyse molecules.	
CO4	Assimilate this XPES quantitative technique and the instrumentation associated with this, as applied in understanding surface of materials.	
CO5	Employ IR and Raman spectroscopic data along with other data for structural and thermodynamic functions investigation of molecules.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	3
CO2	2	2	2	3	3
CO3	2	2	3	3	3
CO4	3	2	3	3	2
CO5	3	2	3	3	3

ELECTIVE - LIST 3 –18. CHARACTERIZATON OF MATERIALS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E18	**CHARACTERIZATON OF MATERIALS**	Elective	3	1	0	3	4	75

Learning Objectives

- To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA.
- To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques.
- To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes.
- To make the students understand some important electrical and optical characterization techniques for semiconducting materials.
- To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.

UNITS	Course Details
UNIT I THERMAL ANALYSIS	Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA) - cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.
UNIT II MICROSCOPIC METHODS	Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy –differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.
UNIT III ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY	SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- Scanning tunneling microscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.
UNIT IV ELECTRICAL METHODS AND OPTICAL CHARACTERISATION	Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.
UNIT V X-RAY AND SPECTROSCOPIC METHODS	Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis-application - Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.

Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Growth and Characterization of semiconductors- R. A. Stradling and P. C. Klipstain, Adam Hilger, Bristol, 1990. 2. Electron microscopy and microanalysis of crystalline materials - J. A. Belk, Applied Science Publishers, London, 1979. 3. Electron and Ion microscopy and Microanalysis principles and Applications- Lawrence E. Murr, Marcel Dekker Inc., New York, 1991 4. Analytical Chemistry- D. Kealey and P. J. Haines, Viva Books Private Limited, New Delhi, 2002. 5. Materials Characterization Techniques- Li, Lin, Ashok Kumar, Sam Zhang; CRC Press, 2008.
REFERENCE BOOKS	1. Elements of X-Ray Diffraction – B.D. Cullity and R.S. Stock, Prentice-Hall, 2001. 2. Fundamentals of Light Microscopy and Electronic Imaging- Murphy B. Douglas, Wiley-Liss, Inc. USA, 2001. 3. Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series)- A.K. Tyagi, Roy, Mainak, S.K. Kulshreshtha and S. Banerjee, Volume 49 – 51, 2009. 4. Thermal Analysis- W.W. Wendlandt, John Wiley & Sons, 1986. 5. Characterization of Materials- J.B. Wachtman,Z.H. Kalman, Butterworth Heinemann, 1993.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Describe the TGA, DTA, DSC and TMA thermal analysis techniques and make interpretation of the results.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	The concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	
CO3	The working principle and operation of SEM, TEM, STM and AFM.	
CO4	Understood Hall measurement, four –probe resistivity measurement, C-V, I-V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	
CO5	The theory and experimental procedure for x- ray diffraction and some important spectroscopic techniques and their applications.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	2	2
CO2	3	3	3	2	2
CO3	3	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	2	2	2

ELECTIVE - LIST 3 – 19. MEDICAL PHYSICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E19	**MEDICAL PHYSICS**	Elective	3	1	0	3	4	75

Learning Objectives

- To understand the major applications of Physics to Medicine
- To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.
- To outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation.
- To introduce the ideas of Radiography.
- To form a good base for further studies like research.

UNITS	Course Details
UNIT I: X-RAYS AND TRANSDUCERS	Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer
UNIT II: BLOOD PRESSURE MEASUREMENTS	Introduction –□sphygmomanometer – Measurement of heart rate – basic principles of electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).
UNIT III: RADIATION PHYSICS	Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness –Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter
UNIT IV: MEDICAL IMAGING PHYSICS	Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display)
UNIT V: RADIATION PROTECTION	Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Basic Radiological Physics, Dr. K. Thayalan ,Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2017. 2. Christensen's Physics of Diagnostic Radiology, Curry, Dowdey and Murry,LippincotWilliams and Wilkins, 1990. 3. Physics of Radiation Therapy, FM Khan, William and Wilkins, 3rd edition, 2012. 4. An Introduction to Biomedical Instrumentation, D. J. Dewhurst, Elsevier Science, 2nd edition, 2014. 5. Hand Book of Biomedical Instrumentations, R.S. Khandpur, TMG, New Delhi, 3rd edition, 2014.
REFERENCE BOOKS	1. An Introduction to Medical Physics, Muhammad Maqbool, Springer International Publishing, 2nd edition, 2018. 2. Basics of Medical Physics, Daniel Jirák, FrantišekVítek, Charles University, Karolinum Press, 1st edition, 2018. 3. Comprehensive Biomedical Physics, Volume 1, Anders Brahme, Elsevier Science, 1st edition, 2014. 4. Bio-Medical Electronics and Instrumentation, K. Venkata Ram, Galgotia Publications, New Delhi, 1st edition, 2001. 5. Medical Physics, John R. Cameron and James G. Skofronick, John Wiley Interscience Publication, Canada, 2nd edition, 2009.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Learn the fundamentals, production and applications of X-rays.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	
CO3	Apply knowledge on Radiation Physics	
CO4	Analyze Radiological imaging and filters	
CO5	Assess the principles of radiation protection	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	3	1	1
CO2	3	3	3	2	1
CO3	3	3	3	2	1
CO4	3	3	3	2	1
CO5	3	3	3	1	1

ELECTIVE - LIST 3 – 20. SOLID WASTE MANAGEMENT

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E20	**SOLID WASTE MANAGEMENT**	Elective	3	1	0	3	4	75

Learning Objectives
➢ To gain basic knowledge in solid waste management procedures ➢ To gain industry exposure and be equipped to take up a job. ➢ To harness entrepreneurial skills. ➢ To analyze the status of solid waste management in the nearby areas. ➢ To sensitize the importance of healthy practices in waste managements.

UNITS	Course Details
UNIT I: SOLID WASTE MANAGEMENT	Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste.
UNIT II: SOLID WASTE CHARACTERISTICS	Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation
UNIT III: TOOLS AND EQUIPMENT	Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique
UNIT IV: ECONOMIC DEVELOPMENT	SWM for economic development and environmental protection Linking SWM and climate change and marine litter.
UNIT V: INDUSTRIAL VISIT	SWM Industrial visit – data collection and analysis - presentation
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Handbook of Solid Waste Management, George Tchobanoglous, McGraw Hill, 2nd Edition, 2002. 2. Prospects and Perspectives of Solid Waste Management, B. B. Hosetti, New Age International (P) Ltd, 2006. 3. Solid and Hazardous Waste Management, M.N Rao and Razia Sultana, BS Publications, 2nd Edition, 2020, 4. Integrated Solid Waste Management Engineering Principles and

	Management Issues, George Tchobanoglous, Hilary Theisen, S. A. Vigil, McGraw Hill, 2014. 5. Solid and Liquid Waste Management, VasudevanRajaram, PHI learning private limited, 2016.
REFERENCE BOOKS	1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012 2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi, 1983. 3. Environmental Studies, D.L. Manjunath, Pearson Education Publication, New Delhi, 2006. 4. Solid Waste Management, K. Sasikumar, PHI learning, New Delhi, 2009.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Gained knowledge in solid waste management	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Equipped to take up related job by gaining industry exposure	
CO3	Develop entrepreneurial skills	
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	3	2
CO2	2	3	3	2	2
CO3	2	3	2	2	2
CO4	3	2	2	2	2
CO5	2	3	3	2	2

ELECTIVE - LIST 3 – 21. SEWAGE AND WASTE WATER TREATMENT AND REUSE

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E21	**SEWAGE AND WASTE WATER TREATMENT AND REUSE**	Elective	3	1	0	3	4	75

Learning Objectives
➢ To gain basic knowledge in sewage and waste water Treatment procedures ➢ To gain industry exposure and be equipped to take up job. ➢ To harness entrepreneurial skills. ➢ To analyze the status of sewage and waste water management in the nearby areas. ➢ To sensitize the importance of healthy practices in waste water management.

UNITS	Course Details
UNIT I: RECOVERY & REUSE OF WATER	Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication
UNIT II: DISINFECTION	Disinfection: Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile -Bacteriostatic and Bactericidal - factors affecting disinfection.
UNIT III: CHEMICAL DISINFECTION	Chemical Disinfection: Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment - Disinfection By-Products(DBPs)
UNIT IV: PHYSICAL DISINFECTION	Physical Disinfection: Introduction - Ultraviolet Radiation - Solar Disinfection - Heat Treatment - Filtration Methods - Distillation - Electrochemical Oxidation Water Disinfection by Microwave Heating.
UNIT V: INDUSTRIAL VISIT	Industrial visit – data collection and analysis - presentation
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Drinking water and disinfection technique, AnirudhhaBalachandra. CRC press (2013) 2. Design of Water and Wastewater Treatment Systems (CV-424/434), ShashiBushan, Jain Bros (2015) 3. Integrated Water Resources Management, Sarbhukan M M, CBS PUBLICATION, (2013) 4. Environmental Pollution Control Engineering, C.S. Rao, New Age International, 3rd Edition, 2018 5. Pollution control in process industries, S.P. Mahajan, Tata McGraw Hill Publishing Company Ltd., 27th Ed, 2012.
REFERENCE BOOKS	1. Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, IVth Edition, 2020 2. Wastewater Treatment Technologies, MritunjayChaubey, Wiley, 1st Edition, 2021. 3. Wastewater Engineering, Metcalf and Eddy, McGraw Hill Higher Edu., 4th ed., 2017. 4. Industrial Water Pollution Control,W. Wesley Eckenfelder, Jr., McGraw Hill Inc., IIIrd Edition, 1999. 5. Green Chemistry: An Introductory Text, Lancaster, RSC publishing, 2nd edition, 2010.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gained knowledge in solid waste management	**K1**
CO2	Equipped to take up related job by gaining industry exposure	**K2**
CO3	Develop entrepreneurial skills	**K3**
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	**K4** **K5**
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	**K6**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	2	2	2	2
CO4	3	2	3	3	2
CO5	2	2	2	2	3

ELECTIVE - LIST 3 – 22. SOLAR ENERGY UTILIZATION

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1E22	**SOLAR ENERGY UTILIZATION**	Elective	3	1	0	3	4	75

Learning Objectives

- To impart fundamental aspects of solar energy utilization.
- To give adequate exposure to solar energy related industries
- To harness entrepreneurship skills
- To understand the different types of solar cells and channelizing them to the different sectors of society
- To develop an industrialist mindset by utilizing renewable source of energy

UNITS	Course Details
UNIT I: HEAT TRANSFER & RADIATION ANALYSIS	Conduction, Convection and Radiation – Solar Radiation at the earth's surface - Determination of solar time – Solar energy measuring instruments.
UNIT II: SOLAR COLLECTORS	Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.
UNIT III: SOLAR HEATERS	Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.
UNIT IV: SOLAR ENERGY CONVERSION	Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells- different approaches on the process- texturization, diffusion, Antireflective coatings, metallization.
UNIT V: NANOMATERIALS IN FUEL CELL APPLICATIONS	Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Solar energy utilization - G.D. Rai, Khanna publishers, 1995. 2. Carbon Nano forms and Applications, Maheshwar Sharon, Madhuri Sharon, McGraw-Hill, 1st Edition, 2010. 3. Solar Energy Engineering: Processes and Systems, Soteris A. Kalogirou, Academic Press, 2009 4. Solar Energy – Fundamentals Design, Modelling and applications, G.N. Tiwari, Alpha Science International Ltd,

	Revised Edition, 2013. 5. Solar Energy, S.P. Sukhatme, Tata McGraw Hill Publishing Company Ltd, 3rd edition, 2008.
REFERENCE BOOKS	1. Energy- An Introduction to Physics – R.H.Romer, W.H.Freeman, 1976 2. Solar energy thermal processes, photovoltaics and wind – John A.Drife and William, Wiley, 5th edition, 2020 3. Renewable Energy Resources, John W. Twidell& Anthony D.Weir, Routledge, 3rd edition, 2005 4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, john Wiley and Sons, 2013

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Gain knowledge in fundamental aspects of solar energy utilization	**K1**
CO2	Understand the physical principles of solar collectors	**K2**
CO3	Develop fundamental skill on solar heater	**K3**
CO4	Understand the basic principle of different types of solar cells	**K4**
CO5	Demonstrate the use of nanotechnology in solar energy conversation	**K5** **K6**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

SKILL ENHANCEMENT COURSES

SKILL ENHANCEMENT COURSE - LIST 4 – 1. DESIGN AND INSTALLATION OF SOLAR PHOTOVOLTAIC SYSTEM

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1SE01	**DESIGN AND INSTALLATION OF SOLAR PHOTOVOLTAIC SYSTEM**	Skill Enhancement	3	1	0	2	4	75

Learning Objectives

- To provide the basics and applications of photovoltaic systems.
- To identify safety hazards of photovoltaic systems.
- To identify practices and protective equipment used for PV systems installation and maintenance.
- To demonstrate solar energy fundamentals
- To conduct site assessments and planning for PV systems installations

UNITS	Course Details
UNIT I: PV SYSTEM BASICS	Introduction to Renewable energy - Basics of Electricity- Solar Radiation Basics and Measurement - Solar Path- Photovoltaic system types- Working of Solar Cells- Solar PV Modules-Solar PV Module Arrays- combiner box-Surge protection- meters and instruments.
UNIT II: ELECTRICAL SYSTEM DESIGN	Basics of Charge Controller-Inverter Basics-Solar Batteries- audit an electricity bill-Site audit & assessment-Components Selection-Balance of Systems Components.
UNIT III: SAFETY SYSTEM	Safety in Installation of Solar PV Systems-Solar PV Systems Design and integration -PV Battery System Design-PV Controller System Design-PV Inverter System Design.
UNIT IV: DEVICE INSTALLATION	Photovoltaic System Sizing -Solar PV Plant Installation Check List-Installation of Solar PV Power Plants -Plant Operation and Maintenance-Troubleshooting of Solar PV Power Plants.
UNIT V: PV DESIGN CONSIDERATIONS	Site inspection - shade calculations - roof assessments-solar panel location and spacing, floodplains, power line and battery locations - circuit boxes- pros and cons of rooftop and ground-mounted systems.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Large-Scale Solar Power System Design (Green Source Books): An Engineering Guide for Grid-Connected Solar Power Generation, Peter Gevorkian, Mcgraw-hill's resource Series, 2011. 2. Designing & Installing Solar PV Systems (Electronic PDF Textbook), Jay Warmke – 2nd edition (ISBN: 978-1-957113-03-6 electronic), 2022. 3. Solar PV System: Design, Installation, Operation and Maintenance, L.Ashok Kumar, K. Mohana Sundaram, Nova Publication, 2011. 4. Solar Power Systems Design From the Sun Into Electricity, Taleb Al-theanat, Global Institute of Electrical Engineering | GIEE, 2017.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Understand the characteristics of different PV system configurations	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Calculating PV module parameters using module specifications	
CO3	Study various PV technologies and their applications.	
CO4	Analyzing photovoltaic system performance	
CO5	Calculating photovoltaic array and BOS component sizing	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

SKILL ENHANCEMENT COURSE - LIST 4 – 2. ANALYTICAL INSTRUMENTAL METHODS

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1SE02	**ANALYTICAL INSTRUMENTAL METHODS**	Skill Enhancement	3	1	0	2	4	75

Learning Objectives

- To interpret the measurements and interpret the different types of errors.
- To understand the operating principles, construction and working of various analytical instruments.
- To able to analyze the different property of surface of materials
- To get an insight on the basic principles to application of different optical analysis
- To probe the electrochemical property and fabricate electrochemical cells

UNITS	Course Details
UNIT I: ERRORS AND ANALYSIS OF EXPERIMENTAL DATA	Types of errors – Mean, variance - standard deviation – sampling techniques. Thermal Analysis- Thermo gravimetric analysis – instrumentation of weight loss and decomposition products – differential scanning calorimetric – instrumentation – specific heat capacity.
UNIT II: ELECTRICAL METHODS	Electrical Methods: Hall Effect – carrier density – resistivity – two probe and four probe methods – scattering mechanism – Schottky barrier capacitance – impurity concentration – limitations.
UNIT III:SURFACE MICROSCOPY	Study of surfaces- Principle – Instrumentation – sample preparation – analysis of materials - Applications of SEM, TEM, AFM and STM.
UNIT IV: OPTICAL ANALYSIS	Photoluminescence – light-matter interaction – fundamental transitions – excitons – instrumentation – electroluminescence – instrumentation- Principle of UV-DRS and UV-Visible – sample preparation – analysis of materials-applications
UNIT V: ELECTROCHEMICAL ANALYSIS	Electrochemical cells- cell potentials - potentiometry - reference and counter electrode- instrument for potentiometric studies -cyclic and pulse voltammetry- application of voltammetry
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Instrumental Methods of Analysis - Willard. M, Steve. D, CBS Publishers, New Delhi, 1986. 2. Instrumental Method of Analysis, Willard, Hobart, et al, Wadsworth Publishing Co Inc, VII th Edition, 2001. 3. Electron Microscopy and Microanalysis of Crystalline materials ,R.AStradling, Applied Science Publishers, London, 1979. 4. Electron microscopy and Microanalysis of Crystalline Materials, J.A Belk, Applied Science Publishers, London, 1st Edition, 1979.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Interpret the measurements and interpret the different types of errors.	**K1**
CO2	Understand the operating principles, construction and working of various analytical instruments.	**K2**
CO3	Able to analyse the different properties of surface of materials	**K3**
CO4	Get an insight into the basic principles of application of different optical analysis	**K4**
CO5	Probe the electrochemical property and fabricate electrochemical cells	**K5**
		K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

SKILL ENHANCEMENT COURSE - LIST 4 – 3. INDUSTRIAL SEMICONDUCTOR DEVICES

Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1SE03	**INDUSTRIAL SEMICONDUCTOR DEVICES**	Skill Enhancement	3	1	0	2	4	75

Learning Objectives
➢ Familiarize with semiconductor basics and device fabrication steps ➢ To develop background knowledge and core expertise related to lithography ➢ Understand the basic concepts involved in the fabrication technique. ➢ Acquire knowledge and apply it to MEMS technology ➢ To understand the parameters and applications of Regulated Power Supplies

UNITS	Course Details
UNIT I: FUNDAMENTALS OF MICRO AND NANO FABRICATION	Crystal Structure and Crystal Defects of semiconductor substrates- Bridgman Growth- Float Zone Growth- Wafer Preparation. Substrate -Introduction to cleanroom - Advanced cleaning techniques
UNIT II: LITHOGRAPHY	Overview- Diffraction- Source Systems and Spatial Coherence- Projection Printers- Advanced Mask Concepts- Surface Reflections and Standing Waves- Alignment
UNIT III: ETCHING	Wet Etching- Chemical Mechanical Polishing- High-Pressure Plasma Etching- Reactive Ion Etching- Damage in Reactive ion Etching- High-Density Plasma (HDP) Etching.
UNIT IV: MEMS	Fundamentals of Mechanics- Stress in Thin Films- Mechanical to Electrical Transduction- Mechanics of Common MEMS Devices- MEMS Actuators- High-Aspect Ratio Microsystems Technology.
UNIT V: REGULATED POWER SUPPLIES	Supply characteristics- Shunt regulators- Series regulators- monolithic linear regulator- current boosters- DC to AC converters- switching regulators.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Semiconductor Devices Physics and Technology - S. M. Sze, Wiley Publication, 2nd Edition, 1985. 2. Physics of semiconductor devices - S.M. Sze and Kwok K. NgWiley, Third Edition, 2007. 3. A Text Book of INDUSTRIAL ELECTRONICS V. G. Yangalw, Published By nirali prakashan,2018. 4. ELECTRONICS Semiconductor Physics and Devices: Basic Principles- D. A. Neamen, McGraw-Hill, 3rd Edition, 2003.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Provide the basic knowledge and also an overview of fundamentals fabrication	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Study the sources and basic concepts of lithography	
CO3	Gain knowledge in design techniques of etching	
CO4	Acquires an ability to analyse and design MEMS.	
CO5	Develop the fundamental concepts and techniques used in regulated power supplies.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

SKILL ENHANCEMENT COURSE - LIST 4 – 4. SILICON WAFER TECHNOLOGY FOR PHOTONICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1SE04	**SILICON WAFER TECHNOLOGY FOR PHOTONICS**	Skill Enhancement	3	1	0	2	4	75

Learning Objectives

- To provide students with a comprehensive understanding of the principles and techniques of silicon wafer technology for photonics.
- To familiarize students with the unique properties and advantages of using silicon as a material platform for photonic devices.
- To introduce students to the fabrication processes and design considerations for silicon photonic devices.
- To explore the various types of silicon-based photonic devices and their applications in optical communications, sensing, and biophotonics.
- To examine the challenges, emerging trends, and future prospects in the field of silicon photonics.

UNITS	Course Details
UNIT I: INTRODUCTION TO SILICON WAFER TECHNOLOGY AND PHOTONICS	Introduction to silicon wafer technology - relevance in photonics - light-matter interactions and photonic devices - silicon as a material platform for photonics – Introduction to optical waveguides- properties in silicon photonics- silicon photonic circuits
UNIT II: SILICON-BASED PHOTONIC DEVICES	Silicon photonics modulators: Mach-Zehnder interferometers- ring resonators- and electro-optic effects- Silicon-based photodetectors and photodiodes -Silicon light sources: lasers and LEDs - Silicon photonic switches and routers-Performance metrics and characterization
UNIT III: SILICON PHOTONICS FOR OPTICAL COMMUNICATIONS	Overview of optical communication systems- Silicon photonics transceivers and modulators for high-speed data transmission- Wavelength division multiplexing (WDM) systems -silicon photonics integration- Silicon-based optical interconnects for data centers- Challenges and future trends - commercial applications in optical communications
UNIT VI: SILICON-BASED PHOTONIC INTEGRATED CIRCUITS	Introduction to photonic integrated circuits (PICs)- Silicon photonics platform: silicon-on-insulator (SOI) -complementary metal-oxide-semiconductor (CMOS) compatibility-PIC design -Fabrication processes for silicon-based PICs- Fabrication techniques for silicon photonic devices- PIC packaging and assembly techniques- Emerging trends and their applications

UNIT V: SILICON PHOTONICS FOR SENSING AND BIOPHOTONICS	Introduction to Silicon photonic biosensors- principles and designs-Label-free sensing techniques -applications-Silicon photonics for chemical sensing - environmental monitoring-Biomedical applications of silicon photonics-Advances in silicon photonics - sensing and biophotonics-Future prospects and challenges.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Silicon Photonics: An Introduction, Dinesh Bhatia, CRC Press, 1st Edition, 2019. 2. Silicon Photonics: Principles and Practices, R.K. Shevgaonkar and N. K. Viswanathan, McGraw-Hill Education, 1st Edition, 2018. 3. Silicon Photonics: Fundamentals and Devices, Graham T. Reed and Andrew P. Knights, Wiley, 1st Edition, 2012. 4. Silicon Photonics: An Introduction, Shuji Ikeda and Yuriko Maegami, Springer, 1st Edition, 2020. 5. Silicon Photonics: Principles and Practices, Prakash Prasad, CRC Press, 1st Edition, 2012.
REFERENCE BOOKS	1. Silicon Photonics: The State of the Art, Graham T. Reed and Andrew P. Knights, Wiley, 1st Edition, 2008. 2. Introduction to Silicon Photonics, AnujDhawan and VivekRaghunathan, Springer, 1st Edition, 2016. 3. Foundations of Silicon Photonics, BahramJalali and SasanFathpour, Cambridge University Press, 1st Edition, 2018. 4. Silicon Photonics: Advanced Devices and Applications, LorenzoPavesi and David J. Lockwood, Springer, 1st Edition, 2013.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Gain knowledge of the principles of silicon wafer technology and its relevance to photonics.	**K1 K2 K3 K4 K5 K6**
CO2	Familiar with a range of silicon-based photonic devices, including modulators, detectors, light sources, and integrated circuits, and understand their functionalities.	
CO3	Able to design and simulate simple silicon photonic components and circuits using appropriate software tools.	
CO4	Grasp the awareness of the applications of silicon photonics in optical communications, sensing, and biophotonics	
CO5	Contribute to research and development in the field of silicon wafer technology for photonics, or pursue further studies in related areas.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	3	2
CO2	3	3	2	3	3
CO3	3	3	2	3	2
CO4	3	3	2	3	3
CO5	3	3	2	3	3

SKILL ENHANCEMENT COURSE - LIST 4 – 5. BIOMATERIALS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1SE05	**BIOMATERIALS**	Skill Enhancement	3	1	0	2	4	75

Learning Objectives

- Understand how the basic engineering materials can be used as the biomaterials
- Apply and transfer interdisciplinary approaches in the biomedical field and others
- Gain knowledge on calcium phosphate biomaterials
- Study the different characterization techniques to analyze biomaterials
- Know the different applications of biomaterials

UNITS	Course Details
UNIT I: INTRODUCTION TO BIOMATERIALS	Biomaterials - historical development- impact of biomaterials - metals (stainless steels – cobalt chromium alloys -titanium based alloys) – ceramics-surface reactive ceramic- resorbable ceramics (Calcium phosphate based ceramic materials)
UNIT II: POLYMERIC BIOMATERIALS	Synthetic polymers and its biomedical use - Hydrogel - Polyurethanes - Polyamides – biopolymers - collagens- Gelatin - Chitin and chitosan - Alginate - Cellulose
UNIT III: CALCIUM PHOSPHATE CERAMICS	Chemistry of calcium phosphate bioceramics – preparation, mechanical properties and biological performance of tri-calcium phosphate, biphasic calcium phosphate, hydroxyapatite and other phosphates - calcium phosphate bone cements – preparation, properties - setting behavior and bio compatibility.
UNIT VI: CHARACTERIZATIONS OF BIOMATERIALS	Characterization of biomaterials - X-ray diffraction - Fourier transform infrared spectroscopy- scanning electron microscopy- transmission electron microscopy - thermal analysis: TGA, DSC and DTA- Elemental analysis: XRF and ICP- density and porosity measurements-microhardness
UNIT V: APPLICATIONS OF BIOMATERIALS	Tissue grafts - tissue engineering – biosensors - drug delivery systems-orthopedic implants - knee joint repair - dental implants - oral implants, bioprobes.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Biomaterials, Sujata V. Bhat, Narosa Publishing House, 2nd Edition, 2005. 2. Bioceramics and their clinical applications, T. Kokubo, Woodhead Publishing Limited, Cambridge, 2008. 3. Biomaterials: A Nano Approach, S. Ramakrishna, M. Ramalingam, T.S. SampathKumar,W.O. Soboyejo, CRC press, 2010. 4. Adsorption analysis: equilibria and kinetics, Vol. 2, Duong D. Do., Imprical college press, 1998. 5. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Yang Leng, John Wiley & Sons, 2009.
REFERENCE BOOKS	1. Biomaterials - Principles and Applications, Park J. B and Bronzino J. D., CRC press, 2002. 2. Biomaterials Science: An Introduction to Materials in Medicine, Ratner. B, Hoffman. A, Schoen. F, Lemons. J, Academic Press , 2004. 3. Biomaterials for artificial organs, Michael Lvsaght and Thomas J.Webster, Woodhead publishing Limited, 2011.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand how the basic engineering materials can be used as the biomaterials.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Apply and transfer interdisciplinary approaches in the biomedical field and other fields.	
CO3	Know about calcium phosphate ceramics	
CO4	Analyze biomaterials with different analytical techniques	
CO5	Know the applications of biomaterials	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

SKILL ENHANCEMENT COURSE - LIST 4 – 6. POWDER X-RAY DIFFRACTION AND ANALYSIS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1SE06	**POWDER X-RAY DIFFRACTION AND ANALYSIS**	Skill Enhancement	3	1	0	2	4	75

Learning Objectives

- To make understand X-rays, diffraction, crystal lattice and symmetry.
- To acquire background knowledge on X-ray diffraction from powder crystalline samples.
- To develop background knowledge on point groups
- To acquire knowledge and apply it to identify the structural parameters of crystals
- To understand XRD pattern interpretation

UNITS	Course Details
UNIT I: X-RAYS	X-rays-Charcteristics-Absorption and Filtering- Selection of Radiation- X-Ray tubes: Construction and Geometry-Monochrmatic X-rays – Safety of X-rays
UNIT II: CRYSTAL, PLANES, LATTICES AND X-RAY DIFFRACTION	Crystals-Lattices, Planes and Indices-X-Ray Diffraction- Bragg's Law- Crystal systems - Non-primitive Lattices
UNIT III: RECIPROCAL LATTICE AND CRYSTAL SYMMETRY	Reciprocal Lattice- Bragg's law in reciprocal lattice-Point group and space group symmetry
UNIT IV: POWDER X-RAY DIFFRACTOMETER	Method of Recording X-Ray diffraction: X-ray Diffractometer: X-Ray source- Goniometer- Video camera or Microscope- X-ray detector system-Host computer.
UNIT V: POWDER X-RAY DIFFRACTION AND ANALYSIS	Principle of powder diffraction- powder diffraction pattern-Interpretation of powder photographs-Applications- Limitations.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Powder Diffraction: Theory and Practice -R E Dinnebier, S J L Billinge, Royal Society of Chemistry, 1st Edition, 2008. 2. Introduction to X-Ray Powder Diffractometry -Ron Jenkins, Wiley-Interscience, 1st Edition, 1996.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Know the production of X-rays and diffraction from crystals and symmetry.	**K1**
CO2	Record and Interpret the X-ray diffraction pattern of powder crystalline samples.	**K2**
CO3	Know about reciprocal lattice and crystal symmetry	**K3**
CO4	Understand the powder X-ray diffractometer	**K4**
CO5	Analyze powder X-ray diffraction pattern	**K5**
		K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

NON MAJOR ELECTIVE COURSES

NME - LIST 5 – 1. ELECTRONICS IN DAILY LIFE								
Course Code	**Name of the course**	**Category**	**L**	**T**	**P**	**Credits**	**Inst. Hours**	**Marks**
25UPPHY1NE01	**ELECTRONICS IN DAILY LIFE**	NME	3	1	0	2	4	75

Learning Objectives

- To provide an opportunity for the students from other curriculum to understand the Physics of Electronics
- To understand the construction and operating principles of Electrical, Electronic and communication devices.
- To acquire a knowledge to analyze and design popular electronic technologies.
- To present idea on antennas for communication systems with related issues.
- To know the safety mechanism on handling the electrical and electronic equipment.

UNITS	Course Details
UNIT I: FUNDAMENTALS OF ELECTRONIC COMPONENTS	Basic Electrical and Electronic Symbols – passive and active components- Resistors – Capacitors- Resistance – Capacitance– Electrical quantities – Electrical formulas – Magnetism – Meters – Fuse wire Vacuum diodes - Transistors – Integrated chips.
UNIT II: ELECTRICAL APPLIANCES	Switch board – Main box – Miniature circuit breakers (MCB) – AC – DC currents – Two Phase – Three Phase electrical connections- Method of Earthing – generators – uninterrupted power supply (UPS)- stabilizer – voltage regulators. Electrical devices: Iron box – Fan – Electrical Oven – water Heaters Air conditioners – Refrigerators – washing machines-.
UNIT III: ELECTRONIC HOME APPLIANCES	Radio – Audio taper veaulem, Classification of home appliances - speaker- televisions – VCR – CD Players – DVD – calculators – Computers – scanner – Printer – Digital Camera – LCD Projectors – Display devices.
UNIT IV: COMMUNICATION ELECTRONICS	Principles of optical fiber Cables (OFC) – Telephone – Mobile phones – wireless phone - Antenna - Internet - Intranet.
UNIT V: SAFETY MECHANISM	Handling Electrical appliances - Power saving methods –- Hazards Prevention Methods - Protection of Hi–Fi electronic devices.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS	1. Electronics and Mathematics Data book – S.S. Kamble, Allied publishers Ltd,1997. 2. Study of electrical appliances and Devices - Bhatia, Kanna Publications, Seventh Edition, 2014.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

CO1	Understand the function of different components of electronic circuit.	**K1** **K2** **K3** **K4** **K5** **K6**
CO2	Learn and acquire the basic knowledge of various home appliances such as Iron box, Fan, Electric oven etc., being used in day-to-day life.	
CO3	Study various display system and their applications.	
CO4	Learn the various elements of communication electronics such as Mobile radio, optical fibre, transmission lines, internet etc.,	
CO5	Gain knowledge on safe handling and prevention methods while handling electrical and electronic devices	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

NME - LIST 5 – 2. GEOPHYSICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1NE02	**GEOPHYSICS**	NME	3	1	0	2	4	75

Learning Objectives

- To understand origin of earth,
- To gain ideas about earth's magnetism with magnetosphere.
- To have the cognition about earth quake.
- To attain knowledge about earth temperature and its effect.
- To obtain the fundamental concept of gravitational anomalies.

UNITS	Course Details
UNIT I: EARTH PLANET	Different motions of the earth- gravity field of the earth- Clairaut's theorem- size and shape of earth- geochronology. Seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties of the earth.
UNIT II: GEOMAGNETISM	Geomagnetism – Geomagnetic polarity - Origin of earth's magnetism – elements of earth's magnetic field – inclination, declination and dib - earth's magnetic field – diurnal, annual and secular variations – magnetosphere
UNIT III: SEISMOLOGY BASIC PRINCIPLES OF ELASTICITY AND WAVE MOTION	Primary Seismology wave (P-waves) and Elasticity wave (S-wave) – density within the earth – pressure distribution – variation of "g" and elastic constants - earth quakes – elementary ideas about Ritter's scale
UNIT IV: GEO-THERMAL EFFECT	Fundamentals concept of thermal conductivity – heat flow measurement of on ground level and ocean – heat flow gravity variation – temperature of the primitive earth – inner core – melting point – adiabatic temperature gradient.
UNIT V: GRAVIMETRY	Fundamental concepts of gravitational field – gravitational anomalies – use of gravitational anomalies in geophysical prospecting – petroleum and mineral survey – factors affecting gravitational field due to magnetic storms and cosmic ray showers Mammond and Faller method of absolute gravity measurement – principle and working.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Pedagogy – Concept and applications -J.Sehgal, Kalyani publishers, 2009. 2. Introduction to geophysics (mantle, core and crust) - George G. Garland, W.B. Saunder's company, 1979. 3. Physics and Geology - Jacobbs, Russel and Wilson, International Students Edition, Tata McGraw Hill, 1959. 4. Rock Magnetism - Nagata, McGraw Hill Publications, 1961.

	5. Geology - Debrin, McGraw Hill Publications, 2016.
REFERENCE BOOKS	1. Treatise on Geophysics: Volume 9 Evolution of the Earth By Stevenson David, 2015 2. Biography of the earth (Its past, present and future) - George Gamove, Macmillon Company Ltd, 2017. 3. Geodynamics and Earth Tides Observations from Global to Micro Scale By Carla Braitenberg, Giuliana Rossi, 2019

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand the origin of earth.	**K1**
CO2	Understand the earth's magnetism and its implications.	**K2**
CO3	Acquire knowledge earth's elasticity, wave motion and earth quake.	**K3**
CO4	Explain earth's thermal effect.	**K4**
CO5	Understand gravimetry and geological survey for minerals and oils.	**K5**
		K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	3	2
CO2	3	3	2	3	3
CO3	3	3	2	3	2
CO4	3	3	2	3	3
CO5	3	3	2	3	3

NME - LIST 5 – 3. MOLECULAR BIOPHYSICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1NE03	**MOLECULAR BIOPHYSICS**	NME	3	1	0	2	4	75

Learning Objectives

- To study the chemical binding of molecules
- To have the basic knowledge about the cells and molecules
- To elucidates the health and disease-related mechanisms at the molecular and even atomic levels.
- To understand the physics of biomolecules and Bioenergetics
- To learn the memory system

UNITS	Course Details
UNIT I: CHEMICAL BINDING	**Chemical Binding:** Quantum mechanics-Pauli exclusion Principle – Ionisation energy – electron affinity – chemical binding – electro negativity – strong bonds – secondary bonds. **Energies, Forces and Bonds:** Interatomic potentials for strong bonds – weak bonds – non-central forces – bond energies – spring constants. **Rates of reaction:** Free energy – Internal energy – thermodynamics – statistical mechanics – reaction kinetics – water, acids, bases and aqueous reactions – radiation energy.
UNIT II: CELL: ITS ORGANELLS AND MOLECULES	Prokarytes and Eukaryotes molecular components of cell carbohydrates-lipids-proteins-nucleic acids- Macromolecular structure: Proteins: Amino acid and primary structure – peptide bond and secondary structure- α-helix and β- sheet - tertiary and quaternary structure of proteins-protein folding-Virus structure.
UNIT III: PHYSICS OF BIOMOLECULES	Molecular mechanism of Genetic information transfer-Genetic code – transfer of Genetic information – molecular mechanism of Protein synthesis - Principle of molecular recognition. Physics of Biological Membranes: Cell membrane –Structure of membranes-transport through membrane – Passive transport – diffusion – active transport-molecular reception
UNIT IV: BIOENERGETICS	Energy consumption - cellular respiration-photosynthesis – photosystem I & II ATP synthesis. Movement of Organisms: Bacterial motion – chemical memory in primitive organisms – muscular moment – Human performance. Excitable membranes: diffusion and mobility of Ion Resting potential . Nerve signals: Passive response – Nerve impulses (Auction Potentials) –the nervous system.
UNIT V: MEMORY	Hebbian learning – Neural network – Auto-association. Control of movement: The Primacy of movement – Ballistic control in a simplified visual system – more sophistical modes of control – the Heterogeneous structures of muscle fibers – central pattern generators – conditional reflexes – volition and tree will – what purpose does consciousness serve – passive verses active in mental processing – the relevant anatomy and physiology – intelligence and creativity.

Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
TEXT BOOKS	1. Biophysics: An Introduction -Rodney - M.J. Cotterill, John Wiley Publication, 2002. 2. Biophysics – VasanthaPattabhi and N. Gautham, Alpha Science International, 2nd edition, 2009. 3. Biophysics - Roland Glacer, Springer Publications, 2012. 4. Elementary Biophysics an Introduction - P. K. Srivastava, Alpha Science International, 2005. 5. Biophysics - M. V. Volkenshtein, Mir Publications, 1983.
REFERENCE BOOKS	1. Physical chemistry:Principles and applications in Biological Sciences- I. Tinoco et al.,Pearson Education,2014 2. Molecular and Cellular Biophysics-M.B. Jackson, Cambridge University Press, 2006. 3. Protein Physics: A course of Lectures-A.V. Finkelstein and O.B. Ptitsyn, Academic Press, 2nd Edition, 2016. 4. Bioinformatics: Sequence and Genome Analysis-D.W. Mount, CSHL Press, 2nd Edition, 2004. 5. Biophysics: Principles and Techniques – M.A. Subramonian, MJP Publishers, 2005.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Interpret the chemical binding	**K1**
CO2	Explain the cells and their structures	**K2**
CO3	Understand the physics of biomolecules	**K3**
CO4	Acquire the knowledge of bioenergetics	**K4**
CO5	Understand the memory system and its functions	**K5**
		K6
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

NME - LIST 5 –4-NON-LINEAR OPTICS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1NE04	**NON-LINEAR OPTICS**	NME	3	1	0	2	4	75

Learning Objectives
➢ To accumulate knowledge of the nonlinear optics and basic level theoretical aspects.
➢ To learn important of NLO Materials and applications
➢ To grasp theories behind the nonlinear optical processes
➢ To gain Knowledge about nonlinear optical instrumentation
➢ To get knowledge in nonlinear optical instrumentation for research application

UNITS	Course Details
UNIT I: BASICS OF NONLINEAR OPTICS	Introduction to Linear Optics- Wave propagation in linear medium and Anisotropic Medium- response of materials to light -Nonlinear Frequency Mixing – Centrosymmetric & Non-Centrosymmetric system.
UNIT II: THEORY OF HARMONICS IN NLO MATERIALS	Response of a Harmonic Oscillator- Second Harmonic Generation--Phase Matching-Frequency Conversion- Nonlinear Optical Susceptibilities- Nonlinear Optical Materials-Organic Nonlinear Optical Material- Applications of Nonlinear Optical materials.
UNIT III: HARMONICS GENERATION	Second-order harmonics generation (SHG) - optical rectification - Higher harmonics generation (HHG) - Third order harmonics generation – Phase matching – Optical mixing – Multi photon processing.
UNIT IV: LINEAR AND NONLINEAR SUSCEPTIBILITIES	Absence of χ (2) in centrosymmetric systems - Spatial symmetries and crystal classes - Constraints on the $\chi(1)$ and χ (2) tensors due to spatial symmetries - KDP example - Birefringence.
UNIT V: NONLINEAR INSTRUMENTATION	Kurtz and Perry technique- Nonlinear Refraction and Absorption-Higher order nonlinearity- Third-Order Nonlinearity Measurement Techniques: Z-Scan-Pulse propagation through third order nonlinear optical medium
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement
TEXT BOOKS	1. Nonlinear Optics, 3rd Edition, Robert W. Boyd, Elsevier Academic Press, 2007. 2. Nonlinear Fiber Optics, 4th Edition, G.P. Agarwal, Academic, 2007. 3. Electromagnetic Fields and Energy, Joseph W. Haus and Richard Boudreaux, Prentice Hall, 2000. 4. Nonlinear Fiber Optics, Govind P. Agrawal, Academic Press, 2001.

	5. Introduction to Nonlinear Optics, Peter E. Powers, CRC Press, 2012.
REFERENCE BOOKS	1. Handbook of Nonlinear Optics, 2nd Edition, R.L. Sutherland, Marcel Dekker, 2003. 2. Fundamentals of Nonlinear Optics, P.E. Powers, CRC Press, 2nd edition 2017. 3. Principles of Nonlinear Optics, Y.R. Shen, Wiley, 1984. 2. Nonlinear Optics, 4th Edition, N. Bloembergen, World Scientific, 1996. 3. Introduction to Nonlinear Laser Spectroscopy, Boris Lembrikov, Academic Press, 2003.

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Develop a comprehensive understanding on the basic nonlinear Optics	**K1**
CO2	Learn how to utilize the nonlinear Optical Materials	**K2**
CO3	Understand the various process in nonlinear optics	**K3**
CO4	Understand the basics nature of linear and nonlinear susceptibilities	**K4** **K5**
CO5	Establish the knowledge of characteristics of the Nonlinear properties	**K6**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	2	2
CO2	2	3	3	2	2
CO3	2	3	2	2	2
CO4	1	3	2	3	2
CO5	2	3	2	2	2

NME - LIST 5 – 5. LASER PHYSICS AND APPLICATIONS

Course Code	Name of the course	Category	L	T	P	Credits	Inst. Hours	Marks
25UPPHY1NE05	**LASER PHYSICS AND APPLICATIONS**	NME	3	1	0	2	4	75

Learning Objectives
➢ To study the Einstein's theory of Lasers.
➢ To get knowledge about Lasers characteristics and properties.
➢ To study the different type of Laser systems involving low density and high density gain media.
➢ To learn the Laser Spectroscopic Techniques and its Applications.
➢ To understand the Meteorological Applications such as Lidar, Satellite & Lunar Range finders.

UNITS	Course Details
UNIT I: **BASIC PHYSICS ON THE OPERATION OF LASERS**	Basic Principle of Laser – Einstein Coefficients – Condition for light amplification – Population Inversion – Threshold Condition – Line Shape Function – Optical Resonators – Three level and four level systems.
UNIT II: **LASER CHARACTERISTICS GAUSSIAN BEAM AND ITS PROPERTIES**	Stable two mirror optical resonators, Longitudinal and Transverse Modes of Laser cavity – Mode selection - gain in a Regenerative Laser cavity – Threshold for 3 and 4 level laser systems – Q Switching Mode locking pulse shortening _ Pico second & femto second. Operation – Spectral narrowing and stabilization.
UNIT III: **LASER SYSTEMS**	Laser systems involving low density gain media – Nitrogen Laser, Carbon dioxide Laser and Eximer laser. Laser systems involving high density gain media – Ruby Laser, Nd-YAG Laser, Semiconductor Laser, Diode Pumped Solid State Laser, Dye Laser High power semiconductor Diode Laser systems.
UNIT IV: **LASER SPECTROSCOPIC TECHNIQUES AND OTHER APPLICATIONS**	Laser fluorescence and Raman scattering and their use in Pollution studies, Non-linear interaction of light with matter, Laser induced multi photon processes and their applications, Ultra high resolution spectroscopy with laser and its applications, Propagation of light in a medium with variable refractive index, Optical Fibres. Light wave communication. Qualitative treatment of medical and Engineering applications of Lasers.

UNIT V: APPLICATION OF LASAR	Application of laser in industry – cutting and welding – Drilling – Surface Hardening – Medical applications – Laser as diagnostic and therapeutic tool – Holography – Theory of recording and reconstruction – application of Holography.
Extended Professional Component (is a part of internal component only. Not to be included in the external examination question paper)	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.
TEXT BOOKS	1. Principle of Lasers –OrazioSvelto, Plemum Publishing Corporation, Fifth Edition, 2010 2. Laser Fundamentals - William Silfvast, Cambridge University Press, Second Edition, 2004. 3. Lasers and Non-linear Optics - B.B.Laud, Wiley Eastern Ltd, Third Edition, 2011. 4. Lasers - Lengyel, Wiley Inter Science, 1962. 5. Lasers: Fundamentals and Applications, Ajoy Ghatak, K. Thyagarajan, Springer Publication, 2012
REFERENCE BOOKS	1. Lasers in Chemistry, David L. Andrews, Springer-Verlag, Second Edition, 1990. 2. Medical Applications of Lasers: Laser ablation: principles and applications, John C. Miller, Publisher: Berlin; New York: Springer Verlag, 1994. 3. Laser applications in medicine and biology, M. L. Wolbarsht, 4. Publisher: New York, Plenum Press, 1971 5. Optics and lasers: including fibers and optical waveguides, Matt Young, Publisher: Berlin; New York : Springer-Verlag, 1992. 6. Lasers: Principles, Types and Applications, K. R. Nambiar, New Age International (P) Limited, 2006

COURSE OUTCOMES:

At the end of the course the student will be able to:

CO1	Understand and Interaction of radiation with matter	**K1**
CO2	Understand the Characterization of Lasers and their applications	**K2**
CO3	Understand the Laser systems involving high density media	**K3**
CO4	Differentiate Longitudinal and Transverse Modes of Laser cavity	**K4**
CO5	Get knowledge of Laser Raman scattering and their use in Pollution studies	**K5** **K6**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate; K6 - Create		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	3	3
CO2	2	3	2	2	3
CO3	2	3	2	2	2
CO4	2	2	2	3	2
CO5	2	2	3	2	3

MODEL QUESTION PAPERS

25UPPHY1C02

P.G. DEGREE EXAMINATION, NOVEMBER 2024.
First Semester
Physics
CLASSICAL MECHANICS AND RELATIVITY

Time: Three hours **Maximum: 75 marks**

PART A- (20×1 = 20 marks)
Answer ALL questions.

1. What type of constraint is one that does not depend on time? (CO1, K1)
   (a) Holonomic (b) Non-holonomic
   (c) Conservative (d) Non-conservative
2. The conservation laws for a system of particles are directly derived from which principle? (CO1, K2)
   (a) Newton's First law (b) Hamilton's Principle
   (c) D'Alembert's Principle (d) Principle of Virtual work
3. What term describes the coordinates that completely specify the position of a system? (CO1, K1)
   (a) Generalized Coordinates
   (b) Cyclic Coordinates
   (c) Transformation Coordinates
   (d) Cartesian Coordinates
4. In classical mechanics, which quantity is conserved in a closed system with no external forces? (CO1, K2)
   (a) Momentum (b) Velocity
   (c) Position (d) Energy
5. Which principle is fundamental in deriving the Lagrange's equations? (CO2, K2)
   (a) Hamilton's Principle
   (b) D'Alembert's Principle
   (c) Principle of Least Action
   (d) Principle of Virtual work
6. The equation of motion for which system can be derived using Lagrange's equations? (CO2, K3)
   (a) Atwook's Machine (b) Gas Particles
   (c) Free Particle (d) Magnetic Dipole
7. In Lagrangian mechanics, which quantity is not explicitly dependent on time? (CO2, K2)
   (a) Potential Energy (b) Kinetic Energy
   (c) Lagrangian (d) Hamiltonian
8. The motion of a projectile can be analysed using which type of formulation? (CO2, K3)
   (a) Lagrangian
   (b) Newtonian
   (c) Quantum
   (d) Hamiltonian
9. The Hamiltonian of equivalent to its: a system is typically (CO3, K1)
   (a) Potential Energy
   (b) Kinetic Energy
   (c) Total Energy
   (d) Momentum
10. Which coordinates are used to describe the phase space of a system? (CO3, K2)
    (a) Cartesian Coordinates

(b) Polar Coordinates
(c) Cyclic Coordinates
(d) Generalized Coordinates

11. Hamilton's equations of motion are derived from which principle? (CO3, K2)
(a) Variational Principle
(b) D'Alembert's Principle
(c) Principle of Virtual work
(d) Newton's Laws

12. The motion of a particle in a central force field can be analysed using: (CO3, K3)
(a) Newtonian Mechanics
(b) Lagrangian Mechanics
(c) Hamiltionian Mechanics
(d) Electromagnetic Theory

13. Hamilton-Jacobi theory is primartily used to solve which type of problem? (CO4, K2)
(a) Simple Harmonic Motion
(b) Projectile Motion
(c) Central Force Problem
(d) Quantum Mechanics problem

14. The frequencies of normal modes are primarily calculated for which type of system? (CO4, K3)
(a) One-dimensional particle (b) Rigid body
(c) Simple Pendulum (d) Triatomic Molecule

15. Which coordinates are used to simplify the problem in small oscillations? (CO4, K2)
(a) Cartesian Coordinates
(b) Polar Coordinates
(c) Normal Coordinates
(d) Generalized Coordinates

16. Action-angle variables are most commonly applied to which type of system? (CO4, K4)
(a) Harmonic Oscillator
(b) Central Force Problem
(c) Projectile Motion
(d) Rotational Motion

17. The inverse-square law of force applies to: (CO5, K2)
(a) Kepler's Problem
(b) Projectile Motion
(c) Harmonic Oscillator
(d) Triatomic Molecule

18. The relativistic addition of velocities is calculated using which theory? (CO5, K2)
(a) Classical Mechanics
(b) Newtonian Mechanics
(c) Special Relativity
(d) Quantum Mechanics

19. In relativity, which quantity is invariant for all observers? (CO5, K3)
(a) Time (b) Distance
(c) Mass-energy (d) Velocity

20. Einstein's mass-energy relation is expressed as: (CO5, K1)
(a) $E = mc^2$ (b) $E = mv^2$
(c) $F = ma$ (d) $P = mv$

PART B - (3 × 5 = 15 marks)

Answer any THREE of the following questions.

21. Analyze the implications of conservation laws (energy, momentum, and angular momentum) in a closed system with no external forces. Provide examples to illustrate each law. (CO1, K4)
22. Evaluate the benefits and limitations of using Lagrangian mechanics over Newtonian mechanics, especially for systems with constraints. (CO2 K5)
23. Analyze the significance of phase space in Hamiltonian mechanics and its application in understanding the behaviour of dynamic systems. (CO3, K4)
24. Evaluate the role of the Hamilton-Jacobi equation in connecting classical mechanics to quantum mechanics. (CO4, K5)
25. Create a comparison of time dilation and length contraction in special relativity, discussing their interrelation and physical consequences. (CO5, K6)

PART C (5 x 8 = 40 marks)

Answer ALL questions.

Each question carries Eight marks.

26. (a) Define the mechanics of a single particle and explain how Newton's laws apply to it. (CO1, K1)

Or

(b) Describe holonomic and non-holonomic constraints with examples. Discuss their impact on a system's degrees of freedom. (CO1, K2)

27. (a) Explain D'Alembert's principle and its significance in dynamics. (CO2, K1)

Or

(b) Derive the Lagrange equation of motion for a simple pendulum. (CO2, K3)

28. (a) Define the Hamiltonian function and discuss its physical significance in mechanics. (CO3, K1)

Or

(b) Explain Hamilton's equation of motion and derive them using a simple example. (CO3, K3)

29. (a) Define the Hamilton-Jacobi equation and discuss its role in mechanics. (CO4, K2)

Or

(b) Discuss the concept of normal modes in small oscillation theory. (CO4, K3)

30. (a) Explain the Inverse-Square Law of Force and its significance in central force motion, especially in Kepler's problem. (CO5, K2)

Or

(b) Define time dilation in special relativity and derive its formula. (CO5, K3)

25UPPHY1E02

P.G. DEGREE EXAMINATION, NOVEMBER 2024

First Semester
Physics

PHYSICS OF NANOSCIENCE AND TECHNOLOGY

Time: Three hours **Maximum: 75 marks**

PART A (20 x 1 = 20 marks)
Answer ALL the questions.

1. Who coined the term "nanotechnology"? (CO1, K1)
   (a) Richard Feynman (b) Norio Taniguchi
   (c) Eric Drexler (d) Gerd Binnig
2. Which of the following is a 0D nanomaterial? (CO1, K2)
   (a) Nanowire (b) Nanotube
   (c) Quantum dot (d) Thin film
3. What is the main focus of nanotechnology? (CO1, K1)
   (a) Studying atoms individually
   (b) Manipulating matter at the atomic and molecular scale
   (c) Developing large-scale machines
   (d) Observing distant galaxies
4. Which property becomes significant in nanomaterials due to their large surface area-to-volume ratio? (CO1, K2)
   (a) Quantum confinement
   (b) Ferromagnetism
   (c) Optical transparency
   (d) Surface reactivity
6. Superparamagnetism occurs in nanoparticles when their size is typically below: (CO2, K2)
   (a) 100 nm (b) 50 nm
   (c) 10 nm (d) 5 nm
6. What property of nanomaterials is responsible for surface plasmon resonance? (CO2, K3)
   (a) Magnetic (b) Optical
   (c) Thermal (d) Mechanical
7. Which property is typically observed in diluted magnetic semiconductors? (CO2, K3)
   (a) Superconductivity (b) Superparamagnetism
   (c) Dielectric behavior (d) Ferroelectricity
8. Which of the following properties of nanomaterials is primarily affected by their high surface area-to-volume ratio? (CO2, K3)
   (a) Melting point
   (b) Magnetic behaviour
   (c) Electrical conductivity
   (d) Mechanical strength
9. Which method is commonly used for the large- scale synthesis of nanofibers? (CO3, K1)
   (a) Ball milling
   (b) Electrospinning
   (c) Chemical vapor deposition

(d) Sol-gel

10. In the sol-gel method, the starting material are typically: (CO3, K2)
    (a) Solids
    (b) Solutions
    (c) Gases
    (d) Ponders
11. Electrospinning is typically used for the synthesis of which type of structure? (CO3, K3)
    (a) Nanoparticles
    (b) Nanowires
    (c) Nanofibers
    (d) Nanorods
12. In which method are nanoparticles typically produced by condensing vaporized material onto a substrate? (CO3, K2)
    (a) Chemical vapour deposition
    (b) Wet deposition
    (c) Ball milling
    (d) Plasma arching
13. Which technique is used to determine the crystal structure of nanomaterials? (CO4, K2)
    (a) X-ray diffraction (XRD)
    (b) Scanning electron microscopy (SEM)
    (c) Atomic free microscopy (AFM)
    (d) UV-visible spectroscopy
14. What does TEM stand for in characterization techniques? (CO4, K3)
    (a) Transmission Electromagnetic Microscopy
    (b) Transmission Electron Microscopy
    (c) Thin Electron Microscopy
    (d) Total Energy Microscopy
15. Which of the following microscopes provides atomic resolution by detecting tunnelling current? (CO4, K2)
    (a) Scanning electron microscopy (SEM)
    (b) Transmission electron microscopes (TEM)
    (c) Scanning tunnelling microscope (STM)
    (d) Atomic force microscope (AFM)
16. Which technique allows the study of magnetic Properties of nanomaterials at various temperatures? (CO4, K3)
    (a) UV-visible spectroscopy
    (b) Vibrating sample magnetometer
    (c) Scanning tunnelling microscopy
    (d) Atomic force microscopy
17. Which nanomaterial is commonly used in drug delivery system? (CO5, K2)
    (a) Carbon nanotubes
    (b) Gold nanoparticles
    (c) Zinc oxide nanowires
    (d) Silver nanoclusters

18. Nanomaterials are used in solar cells primarily to: (CO5, K2)
    (a) Enhance conductivity
    (b) Increase optical absorption
    (c) Improve mechanical strength

(d) Reduce weight

19. What is a primary application of carbon nanotubes in medicine? (CO5, K2)
    (a) Drug delivery (b) Water purification
    (c) Fuel cells (d) Air purification
20. Photocatalytic nanomaterials are commonly used for which environmental application? (CO5,K3)
    (a) Display screens
    (b) Water purification
    (c) Rechargeable batteries
    (d) Nanobots

PART B — (3 x 5 = 15 marks)
Answer any THREE of the following questions.

21. Discuss the impact of surface area on the properties of nanomaterials and explain how this differs from bulk materials. (CO1, K4)
22. Explain the significance of quantum confinement in nanomaterials and how it affects their optical and electronic properties. (CO2, K5)
23. Compare and contrast the sot-gel method and chemical vapour deposition (CVD) for synthesizing nanomaterials, highlighting their advantages and limitations. (CO3, K5)
24. Describe the principle and application of Scanning Electron Microscopy (SEM) in the characterization of nanomaterials. What are limitations of this technique? (CO4, K4)
25. Evaluate the role of nanomaterials in energy applications, focusing on supercapacitors and fuel cells. (CO5, K6)

PART C — (5 x 8= 40 marks)

Answer ALL questions.

Each questions carries 8 marks

26. (a) Describe the surface effects of nanomaterials and their significances in nanotechnology. (CO1,K1)

Or

(b) Discuss the historical perspective of nanomaterials and nanotechnology, highlighting key milestones in its development. (CO1, K2)

27. (a) Describe the mechanical behavior of nanomaterials in terms of strength, ductility, and superplastic behavior (CO2,K1)

Or

(b) Explain the magnetic properties of nanomaterials, focusing on superparamagnetism and diluted magnetic semiconductors (DMS). (CO2,K3)

28. (a) Discuss the different chemical vapour deposition techniques used in nanomaterial fabrication. (CO3,K1)

Or

(b) Describe the role of electrospinning in nanomaterial fabrication and provide example of its applications. (CO3, K3)

29. (a) Explain the working principles of transmission electron microscopy (TEM) and how it differs from scanning electron microscopy (SEM). (CO4, K2)

Or

(b) Discuss the role of X-ray diffraction (XRD) in determining the crystal structure of nano materials. (CO4,K3)

30.(a) Discuss the use of nano biosensors in medical diagnostics and explain their working principles. (CO5,K2)

Or

(b) Describe the role of nanomaterials in energy storage, with examples such as rechargeable batteries and supercapacitors. (CO5, K3)

25UPPHY1N01

P.G. DEGREE EXAMINATION, NOVEMBER 2024.

Third Semester

Physics

ELECTRONICS IN DAILY LIFE

Time: Three hours Maximum: 75 marks

PART A- (20x1=20 marks)

Answer ALL the questions.

1. The unit of Inductance is (CO1, K1)
   (a) Capacitance (b) Ohm
   (c) Farad (d) Henry
2. The unit of electrical resistance is (CO1, K1)
   (a) volt (b) Ampere
   (c) ohm (d) coloumb
3. Fuse in the motor circuit provides (CO1, K2)
   (a) Over load protection
   (b) Short circuit protection
   (c) under load protection
   (d) Both (a) and (h)
4. Current cannot flow to the ground through (CO1, K2)
   (a) A mechanical ground
   (b) Ac ground
   (c) A virtual ground
   (d) An ordinary ground
5. Which of the following refrigerant is widely used in domestic refrigerator (CO2, K1)
   (a) ammonia (b) alcohol
   (c) oxygen (d) neon
6. The heating element in an electric iron is usually made of (CO2, K1)
   (a) brass (b) iron
   (c) nichrome (d) platinum
7. The main purpose of earthing is (CO2, K1)
   (a) To main the line voltage
   (b) To save the human life
   (c) To allow the current to flow to earth in case of fault
   (d) All the above
8. The main function of MCB is (CO2, K1)
   (a) To close the circuit
   (b) To switch off the current instantly automatically
   (c) To prevent the damage of wiring and risk of fire
   (d) All the above
9. A woofer should be led from the input through a (CO3, K2)
   (a) Low pass filter (b) High pass filter
   (c) Band pass filter (d) Band stop filter
10. The property to resist the flow of electrons (CO3, K2)
    (a) capacitance (c) Inductance
    (b) resistance (d) None of these

11. What is the commercial unit of electrical energy? (CO3, K2)
    (a) kWh (b) kW/h
    (c) kW (d) W
12. Unit of electric power may also be expressed as (CO3, K1)
    (a) Volt ampere (b) Kilowatt hour
    (c) Watt second (d) Joule second
13. In n optical fibre communication system, which among the following is not a typical transmitter function (CO4, K1)
    (a) Coding for error protection
    (b) Decoding of input data
    (c) Electrical to optical conversion
    (d) Recording to match output standards
14. Which type of ground wave travels over the earth surface by acquiring direct path through air from transmitting to receiving antennas (CO4, K1)
    (a) Surface wave (b) Space wave
    (c) Both (a) and (b) (d) None of the above
15. Which type of wire antennas are also known as dipoles? (CO4, KI)
    (a) linear (b) Ioop
    (c) helical (d) All the above
16. In an optical fiber, the concept of numerical aperture is applicable in describing the ability of (CO4, K1)
    (a) Light collection (b) Light scattering
    (c) Light dispersion (d) Light polarization
17. Why is parallel arrangement used in domestic wiring? (CO5, K1)
    (a) The circuit is not broken in parallel arrangement
    (b) All the appliance work at the same voltage
    (c) If the bulb get fused all other appliances keep on working
    (d) All the above
18. What is the minimum safe distance to maintain overhead power line? (CO5, K1)
    (a) 2 feet (b) 5 feet
    (c) 10 feet (d) 15 feet
19. What is the color coding for the ground wire in electrical systema? (CO5, K1)
    (a) red (b) black
    (c) green (d) vellow
20. Which type of fire extinguishor is suitable for electrical fires (CO5, K1)
    (a) Water based extinguisher
    (b) Foam based extinguisher
    (c) CO, extinguisher
    (d) Powder extinguisher

PART B-(3x5=15 marks)
Answer any THREE of the following questions

21. Derive mathematical relation of equivalent capacitance of few capacitors connected in series combination. (CO1, K4)
22. In an electrical circuit three incandescent bulbs A B and C of rating 40 W, 60 W and 100 W respectively are connected in parallel to an electric source. Discuss what would happen regarding their brightness? (CO2 K4)
23. Discuss the function of the seven segment display in calculator (CO3, K4)
24. A carrier of 100 V and 1200 kHz is modulated by a 50 V. 1000 Hz sine wave signal. Find the modulation factor. (CO4, K4)
25. An electric kettle consumes 1 kW of electric power when operated at 220 V. A fuse wire of what rating must be used for it? (CO5, K4)

PART C (5 X 8 = 40 marks)
Answer ALL the questions

26. (a) Discuss the function of capacitor in a circuit (CO1, K2)

    Or

    (b) How and when do you use a resistor? — Explain (CO1, K2)
27. (a) Discuss the construction and working of n refrigerator. (CO2, K1)

    Or

    (b) Write the operating principle of stabilizer and voltage regulators. (CO2, K1)
28. (a) Discuss the functioning of a digital camera. (CO3, K1)

    Or

    (b) Mention the different types of display devices and explain any one of them. (CO3, K1)
29. (a) What are the advantages of optical Fiber communication? (CO4, K1)

    Or

    (b) Discuss the working principle of an antenna. (CO4, K2)
30. (a) How does the use of fuse wire protect the electrical appliances? Explain. (C05, K2)

    Or

    (b) Discuss the necessary methods followed to protect the Hi-Fi electronic devices. (CO5, K2)

INSTRUCTION TO PREPARE THE QUESTION PAPERS

Instruction to Prepare the Question papers

Question Paper Pattern (Theory)

PART	Approaches	Mark Pattern	K Level
A	One word (Answer all questions)	(20 x 1 = 20 (Multiple choice questions)	K1 & K2
B	100 to 200 words (Answer any three out of five questions)	3 x 5 = 15 (Analytical type questions)	K3 & K4
C	500 to 1000 words	5 x 8 = 40 (Essay type questions)	K5 & K6

Core courses

- PART A: Four questions from each unit and among all questions at least five questions must be problem.
- PART B: One question from each unit. In this section, among all questions at least two questions must be Problem and other questions are analytical type.
- PART C: Two questions from each unit. In this section, among all questions at least one question must be a problem, the remaining questions are descriptive.

Elective courses

- PART A: Four questions from each unit, all are objective type.
- PART B: One question from each unit, all are analytical type.
- PART C: Two questions from each unit, all are descriptive type.

Supportive courses

- PART A: Four questions from each unit, all are objective type.
- PART B: One question from each unit, all are analytical type questions.
- PART C: Two questions from each unit, all are descriptive type questions.