Two-Year Postgraduate Programme

M.Sc.

Physics

Faculty of Applied Sciences

Parul University

Vadodara, Gujarat, India

Faculty of Applied Sciences

Master of Science in Physics

1. **Vision of the Department**
   To be a premier department of physics providing competent and ethical strong foundation in the discipline while exposing them to cutting-edge developments in the field, make them capable of finding solutions to problems related to fundamental concept of technology and scientific advancement.
2. **Mission of the Department**

M1	To create graduates possessing sound fundamental knowledge with practical skills.
M2	To organize and sustain efficient operating systems in the Department for realization of our objectives as Institution of eminence and international standards.
M3	To create manpower for contributing effectively towards societal development with basic aspects.
M4	To motivate faculty and students to do impactful research on industrial needs with ethics to society.

3. **Program Educational Objectives**

   The statements below indicate the career and professional achievements that the M.Sc. in Physics curriculum enables graduates to attain.

PEO 1	To develop technical skills (critical investigation, communication, analytical and computer) and human relations skills (group dynamics, team building, organization and delegation) to enable students to transform the acquired knowledge into action.
PEO 2	The program's structure is multidisciplinary, allowing students to explore the intersections between physics and other fields of study and helps them understand the interconnectedness of various areas of knowledge.
PEO 3	To provide an environment for exploring the Research & Development attitude, to help the students in Research and Development field.

4. **Program Learning Outcomes**

   Program Learning outcomes are statements conveying the intent of a program of study.

PLO 1	**Knowledge:**	Apply the knowledge of mathematics, science, engineering fundamentals, and physics specialization to the solution of complex problems.
PLO 2	**Problem**	Identify, formulate, review research literature, and analyze

	analysis:	complex recent problems reaching substantiated conclusions using basic software tools for natural sciences, and engineering sciences.
PLO 3	**Design/development of solutions:**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PLO 4	**Conduct investigations of complex problems:**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PLO 5	**Modern tool usage:**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PLO 6	**Environment and sustainability:**	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PLO 7	**The engineer and society:**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PLO 8	**Ethics:**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PLO 9	**Individual and team work:**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PLO 10	**Communication:**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PLO 11	**Project management and finance:**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PLO 12	**Life-long learning:**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

5. Program Specific Learning Outcomes

PSO 1	**Demand as per recent development**	Design the solutions as per the recent research demand objective.
PSO 2	**Research skill**	Fundamental concepts to design the system with appropriate usage of software tools, and gather data for modelling system.

6. Credit Framework

Semester wise Credit distribution of the programme	
Semester-1	25
Semester-2	26
Semester-3	36
Semester-4	20
Total Credits:	**107**

Category wise Credit distribution of the programme	
Category	**Credit**
Major Core	107
Minor Stream	0
Multidisciplinary	0
Ability Enhancement Course	0
Total Credits:	**107**

7. Program Curriculum

Semester 1

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	11204107	Advanced Mathematical Physics	5	3	0	2
2	11204108	Solid state Physics	4	4	0	0
3	11204109	Atomic and molecular Physics	4	4	0	0
4	11204110	Classical Mechanics	4	4	0	0
5	11204111	Electronics-I	4	4	0	0
6	11204112	Lab-I	2	0	4	0
7	11204113	Lab-II	2	0	4	0
		Total	25	**19**	**8**	**2**

Semester 2

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
8	11204157	Quantum Mechanics	4	4	0	0
9	11204158	Electrodynamics	4	4	0	0
10	11204159	Nuclear and particle Physics	4	4	0	0
11	11204160	Electronics-II	4	4	0	0
12	11204161	Thermodynamic and statistical Physics	4	4	0	0
13	11204162	Lab-1	2	0	4	0
14	11204163	Lab-2	2	0	4	0
15	11204164	Seminar	2	0	0	2
		Total	26	**20**	**8**	**2**

Semester 3

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
16	11204207	Advanced Quantum mechanics	4	4	0	0
17	11204208	Computational Techniques in Physics	4	4	0	0

18	11204209	Materials science	4	4	0	0
19	11204210	Classical electrodynamics and plasma physics	4	4	0	0
20	11204211	Condensed Matter Physics	4	4	0	0
21	11204212	Nanostructured materials and its applications	4	4	0	0
22	11204213	Luminescence	4	4	0	0
23	11204214	Physics of renewable energy	4	4	0	0
24	11204215	Lab-1	2	0	4	0
25	11204216	Lab-2	2	0	4	0
		Total	36	**32**	**8**	**0**

Semester 4

Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
26	11204253	Physics of solid state devices	4	4	0	0
27	11204254	Experimental and characterization techniques	4	4	0	0
28	11204255	Dissertation	12	0	12	0
		Total	20	**8**	**12**	**0**

8. Detailed Syllabus

Semester 1

Course Name: Advanced Mathematical Physics
Course Code: 11204107
Prerequisite: To use mathematical approach in advanced physics
Rationale: Understand the frequency concept and principles of the tensors

Course Learning Objective:

CLOBJ 1	Explore the theory of complex functions, residues, and contour integrals.
CLOBJ 2	Understand numerical methods for solving mathematical problems, including root finding, numerical integration, and differential equation solvers.
CLOBJ 3	Apply mathematical techniques to solve problems related to physics.
CLOBJ 4	Apply tensor calculus and geometry to describe spacetime, gravitational effects, and relativistic phenomena.

Course Learning Outcomes:

CLO 1	Understand the fundamental concept of stationary states and Perturbation theory.
CLO 2	Explain the change in behavior of atomic level in external applied electric and magnetic fields.
CLO 3	Explain Laplace Transform Applications of Laplace Transform.
CLO 4	Gain Knowledge about the group theory.
CLO 5	Utilize their knowledge to identify the energy level spectra of atoms.

Teaching and Examination Scheme:–

Teaching Scheme				Examination Scheme					
				Internal			External		Total
L	T	P	C	T	CE	P	Theory	P	
3	2	0	5	20	20	-	60	-	100

Lect - Lecture, **Tut** - Tutorial, **Lab** - Lab, **T** - Theory, **P** - Practical, **CE** - CE, **T** - Theory, **P** - Practical

Course Content:

Sr.	Topic	Weightage	Teachin gHrs.
1	**Integral Transforms**: Development of Fourier integral, Properties of Fourier transform,Inversion theorem, Convolution theorem, Fourier transform of derivatives, Applications. Laplace's transform and its properties, Laplace's transform of derivatives, Convolution theorem, Inverse Laplace's transform,Applications.	25%	11
2	**Complex variables**: Analytical functions, Cauchy-Riemann conditions, Cauchy's representation, Laurent series expansion, Residue theorem, Evaluationof definite integrals by use of Residue theorem, Branch point, Branch cut and integration around branch cut, Conformal mapping and its applications.	25%	11
3	**Tensors**: Introduction and definition, Index notation, Inner and Outer products,Contraction, Summation convention, Quotient rule, Symmetric and Antisymmetric Tensors, Levi-Civita Tensors, Irreducible Tensors, Metric Tensors, Covariant and Contravariant Tensors	25%	11
4	**Group Theory**: Definition and examples, Group multiplication table, Subgroups, Classes, Homomorphism and Isomorphism, Representation: reducibleand irreducible, Schur's lemma, Characters of representation, Orthogonal groups, Special unitary groups SU (2) and SU (3).	25%	12
	Total	100 %	45

Text Book and Reference Book:

1. Complex variables and applications, J.W. Brown, R.V. Churchill, 8th edition, McGraw Hill (2009).
2. Matrices and Tensors in Physics by A W Joshi 3rd Ed., New Age International (P) Ltd. New Delhi.

3. Introduction to Mathematical Physics, C. Harper, (PHI) 1978.

Course Name: Solid state Physics
Course Code: 11204108
Prerequisite: To study the principles of magnetism and band related theory
Rationale: Calculation of Schrodinger equation and Fermi surfaces
Course Learning Objective:

CLOBJ 1	Understand the basic principles of crystal structures. Explore various types of defects, including point, line, planar, and volume defects. Investigate the impact of defects on the optical properties of ionic crystals.
CLOBJ 2	Study periodic potentials and their role in forming energy bands. Analyze the Schrödinger equation, Bloch theorem, and the Kronig-Penney model. Explain the origin of band gaps and the distinction between metals, insulators, and semiconductors.
CLOBJ 3	Explore electron motion in one dimension and the concept of effective mass. Understand the formation of energy bands and density of states in quantum wells. Investigate the HOMO-LOMO gap and the size dependence of energy and dielectric constant.
CLOBJ 4	Introduce the concepts of Fermi surfaces and reduced zone schemes. Examine the construction of Fermi surfaces, electron orbits, hole orbits, and open orbits. Demonstrate calculations of energy bands using methods such as tight binding and Wigner-Seitz.
CLOBJ 5	Study experimental methods for investigating Fermi surfaces. Explore magnetic phenomena, including diamagnetism, paramagnetism, and electron spin resonance. Understand theories of ferromagnetism, antiferromagnetism, and ferrimagnetism, including the Heisenberg model and the Bloch T3/2 law.

Course Learning Outcomes:

CLO 1	Able to Create models to better comprehend solid matter's physical properties.
CLO 2	Able to Examine the approximations required to construct models in order to comprehend the solid state.
CLO 3	Able to Understand the classical and quantum mechanical laws that can be used to explain solid-state phenomena.
CLO 4	Able to Formulate and comprehend hypotheses that describe solid-state phenomena.
CLO 5	Able to Understand how solid state physics has influenced major technology

	advancements.
CLO 6	Able to describe understanding of how solid state physics has aided the creation of a number of significant technological advancements that have a current and future impact on our lives.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Introduction to crystal defects and Nanoscience**: Point defects, color centers and optical property of ionic crystals; linedefects, planar defects, volume defects. Introduction to nanoscience and application: Energy, time & length scales of interest and their significance, Nanostructures: nano crystals& nanoclusters and their types; Applications of nanoparticles	25%	15
2	**Energy Band Theory**: Periodic potentials and Schrodinger equation, Bloch theorem, Kronig- Penney model, Origin of band gap, Brillouin zones, reduced zone scheme, distinction between metals, insulator and semiconductor, electron motion in one dimension, effective mass, concept of a hole, cyclotron resonance , Confinement of electrons, quantization of energybands, energy bands and density of states of quantum walls. HOMO- LOMO gap, size dependence of energy and dielectric constant.	25%	15

3	**Fermi Surfaces and Metals**: Introduction, Reduced zone scheme, Periodic zone scheme, construction of Fermi surfaces, electron orbits, hole orbits and open orbits, Calculations of energy bands, Tight binding method for energy bands, Wigner -Seitz method, cohesive energy, Pseudopotential method, Experimental methods in Fermi Surface studies, Quantizationof orbits in a magnetic field, de - Haas - Van Alphen Effect, Extremal orbits, Magnetic breakdown.	25%	15
4	Magnetism: Diamagnetism, Paramagnetism, Electron Spin Resonance, Nuclear Magnetic Resonance, Spin Relaxation, Weiss theory of Ferro magnetism, the exchange interaction, The Heisenberg model, Ferromagnetic domains, The Bloch wall, Origin of domains, Neel model of Antiferromagnetism, Neel model of Ferrimagnetism, Spin waves, Magnons in Ferromagnets, The Bloch T3/2 law, Magnons in Antiferromagnets.	25%	15
	Total	100%	60

Text Book and Reference Book:
1. Solid state physics by M. Wahab
2. Solis state Physics by R. Sharivastava

Course Name: Atomic and molecular Physics
Course Code: 11204109
Prerequisite: To get the conclusions and study on structures of atomic and molecular spectra
Rationale: study the analysis based on structure and molecular principles
Course Learning Objective:

CLOBJ 1	Able to Understand the fundamental concept of atomic & molecular spectra.
CLOBJ 2	Able to Explain the change in behavior of atomic level in external applied electric and magnetic field.
CLOBJ 3	Able to explain rotational, vibrational, electronic and Raman spectra of molecules.
CLOBJ 4	Able to understand the theory and working phenomena of to design various Lasers.
CLOBJ 5	Able to Utilize their knowledge to identify the energy level spectra of atoms.

c. **Course Learning Outcomes:**

CLO 1	Able to Understand the fundamental concept of atomic & molecular spectra.

CLO 2	Able to Explain the change in behavior of atomic level in external applied electric and magnetic field.
CLO 3	Able to explain rotational, vibrational, electronic and Raman spectra of molecules.
CLO 4	Able to understand the theory and working phenomena of to design various Lasers.
CLO 5	Able to Utilize their knowledge to identify the energy level spectra of atoms.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

d. Course Content:

	Topic	Weightage	Teaching Hrs.
1	**ATOMIC STRUCTURE AND ATOMIC SPECTRA**: Orbital magnetic dipole moment, space-quantization, Stern-Gerlach experiment for electron spin, Revision of quantum numbers, Non degenerate first order perturbation method, relativistic correction to energy levels of an atom, atom in a weak uniform external electric field – first and second order Stark effect, degenerate stationary state perturbation theory, linear Stark effect for hydrogen atom levels.	25%	15
2	**FINE AND HYPERFINE STRUCTURE OF MOLECULES**: Spin-orbit interaction energy, Hartree theory, LS coupling, origin of spectral lines, selection rules, some features of one-electron, two- electron spectra and X-ray spectra, fine spectra, hyperfine structure,Zeeman effect. Lamb shift. Molecular Structure: The nature of chemical bonds, valence bond approach and molecular orbital approach for molecular bonding (for H2molecule).	25%	15

3	**MOLECULAR SPECTRA**: Rotational levels in diatomic and polyatomic molecules, vibrational levels in diatomic and polyatomic molecules, diatomic vibrating rotator,Born-Oppenheimer approximation, symmetry of the molecules and vibrational levels, experimental techniques of vibrational and rotationalspectroscopy of molecules, polarization of light and Raman effect, Raman Spectroscopy	25%	15
4	**LASERS**: Life time of atomic and molecular states. Multilevel rate equations andsaturation. Coherence and profile of spectral lines. He-Ne Laser, SolidState laser, Free-electron laser. Non-linear phenomenon. Harmonic generation. Liquid and gas lasers, semiconductor lasers.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Atomic and molecular spectroscopy by MC Gupta new age international publication
2. Atomic and molecular Spectra by Raj Kumar
3. Physics of atoms and molecules by Suresh chandra

Course Name: Classical mechanics

Course Code: 11204110

Prerequisite: To define the frequency of canonical transformations and constrains

Rationale: Analysis of rotational motion and variational principle

Course Learning Objective:

CLOBJ 1	To demonstrate knowledge and understanding of the following fundamental concepts in dynamics of particles.
CLOBJ 2	To emphasis the understanding of Classical Mechanics using Lagrangian and Hamiltonian Approach and Variational Principle.
CLOBJ 3	To realize the reduction of a two-body problem to a one-body problem in a central force system.
CLOBJ 4	To understand the concept of planar and spatial motion of a rigid body, Euler's angles, Coriolis effect.
CLOBJ 5	To know about canonical transformations-Hamilton's equations of motion and Poisson Brackets.

a. Course Learning Outcomes:

CLO 1	Able to understand Classical Mechanics, System of particles and principles of

	classical mechanics.
CLO 2	Able to understand importance of D’Alembert Principle, Variational Principle, Lagrangian Dynamics, Hamiltonian Dynamics, Legendre Transformations as well as Principle of least action.
CLO 3	Able to Execute the theories and mathematical equations related to Canonical Transformations & Hamilton-Jacobi theory.
CLO 4	Able to understand the rigid body dynamics including problems,equation of motion.
CLO 5	Able to Solve various problems related with central force including laws of motion.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C-** Credit; **CE**- Continuous Evaluation

b. Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**CONSTRAINED MOTION AND LAGRANGIAN FORMULATION.**: Constraints, Types of Constraints, Principal of Virtual Work, D’Alembert’s principal and its applications (Problems only), (One or Two Problems should be discussed with D’Alembert’s, Lagrangian, Hamiltons from same set of problems) Generalized coordinates, Langrange’s equations of motion, properties of kinetic energy function,theorem on total energy, generalized momenta, cyclic-coordinates, integrals of motion, Jacobi integrals and energy conservation, Conceptof symmetry, invariance under Galilean transformation, velocity dependent potential, electromagneticforces, coupled oscillators	25%	19
2	**HAMILTON’S FORMULATION & VARIATIONAL PRINCIPLE**: Hamilton’s function and Hamilton’s equation of motion, configuration space, phase space and state space, Lagrangian and Hamiltonian ofrelativistic particles and light rays.Variational principle, Euler’s equation, applications of variational principle, shortest distance problem, brachistrochrone	25%	13

3	**CANONICAL TRANSFORMATIONS & POISSON BRACKET**: Canonical transformation, Generators of infinitesimal canonical transformations, symmetry principles and conservation laws, Conditions for canonical transformation and problem, Definition, Identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity,(statement only), invariance of PB under canonical transformation	25%	14
4	ROTATIONAL MOTION & CENTRAL FORCE: Rotating frames of reference, inertial forces in rotating frames, Larmour precision, electromagnetic analogy of inertial forces, effects of Coriolis force, Focoult’s pendulum. Two body central force problem, stability of orbits, condition for closure, integrable power laws, Kepler’s problems, orbits of artificial satellites	25%	14
	Total	100%	60

Text Book and Reference Book:
1. Fundamentals of classical mechanics by B Gupta
2. Classical mechanics 3rd edition by Charles Poole and Harbert Goldstein

Course Name: Electronics-I
Course Code: 11204111
Prerequisite: Work on operation field and the conclusions of FET
Rationale: Modern electronics and their applications

Course Learning Objective:

CLOBJ 1	Able to understand the classification of various power amplifiers based on their amplification efficiency
CLOBJ 2	Able to apply the tech inside technical knowledge related to various ICs in practice which creates a good innovative knowledge
CLOBJ 3	Able to apply the knowledge of JFET and MOSFET in amplifier circuits and other electronic devices
CLOBJ 4	Able to analyze the difference between conventional amplifier and Operational

	amplifier along with various applications of OP-AMP.

Course Learning Outcomes:

CLO 1	Able to apply the knowledge of JFET and MOSFET in amplifier circuits and other electronic devices
CLO 2	Able to apply the tech inside technical knowledge related to various ICs in practice which creates a good innovative knowledge
CLO 3	Able to understand the classification of various power amplifiers based on their amplification efficiency
CLO 4	Able to analyze the difference between conventional amplifier and Operational amplifier along with various applications of OP-AMP.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
				Internal			External		Total
L	T	P	C	T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C-** Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Field Effect transistors (FET)**: Introduction, Advantages and Disadvantages of FET, Operation, Effectof VDS on Channel Conductivity, Channel Ohmic Region and Pinch-offRegion, Characteristic Parameters of FET, Effect of Temperature on FET Parameters, Common source AC Amplifier, Common Drain Amplifier, Common Gate Amplifier, Frequency response of FET Amplifier. **MOSFET:**Depletion MOSFET, Enhancement MOSFET, Differences between JFET and MOSFET, Handling precaution for MOSFET, Dual-Gate MOSFET, Characteristics of dual-gate MOSFET.	25%	15

2	**Digital IC Logic Families**: Digital ICs, Level of Integration, Digital IC Families, Characteristics of Digital ICs, TTL Logic Family - NAND Gate with Totem-pole Output, Types of TTL, TTL parameters: floating inputs, worst-case input/outputvoltages, profile and windows, compactibility, sourcing and sinking, noise immunity, standard loading, loading rules. ECL Logic Family - OR/NOR Gates, I2L Logic Family - NOR Gate, MOS Logic Family - MOS Inverters,NMOS Logic Family - NAND & NOR Gates, CMOS Logic Family - NAND & NOR Gates, CMOS characteristics, TTL to CMOS and CMOS to TTL interface.Comparison of Logic Families.	25%	15
3	**Power amplifiers**: Transistor audio power amplifier- small signal and large signal amplifiers, output power of amplifier, difference between voltage and power amplifier, performance quantities of power amplifiers, classifications of power amplifiers, expression for collector efficiency, maximum collector efficiency for series-fed class-a amplifier, maximumcollector efficiency for transformed coupled class-a amplifier, importantpoints about class-a power amplifier, stages of practical power amplifier-driver stage, output stage, push pull amplifier, maximum efficiency for class-b operation.	25%	15
4	Operational amplifiers & its applications: Operational amplifier, basic circuit of differential amplifier, common modes and differential mode signals, voltage gain of DA, D.C analysis of differential amplifier, parameters of DA due to mismatches of transistor, output voltage from op-amp, bandwidth of an op-amp, frequency response of an op-amp, applications of op-amps.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Electronic devices and circuit theory by Robert Boylstad.
2. Principles of electronics by VK Mehta and Rohit Mehta

Practical

Course Name: Lab-I: Electronics
Course Code: 11204112

Prerequisite: Basic components of electronic circuits
Rationale: digital electronic devices and their operation
Course Learning Objective:

CLOBJ 1	Demonstrate Proficiency in Basic Laboratory Techniques
CLOBJ 2	Apply Theoretical Knowledge to Practical Situations
CLOBJ 3	Conduct Organic Synthesis and Reactions
CLOBJ 4	Use Spectroscopic Methods for Compound Identification.
CLOBJ 5	Practice Safe Laboratory Procedures.

Course Learning Outcomes:

CLO 1	Theoretical concepts from the Organic Chemistry lecture course to design and conduct experiments, demonstrating an understanding of the principles underlying reactions and synthesis.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Carry out organic synthesis and reactions, producing desired products and demonstrating knowledge of reaction mechanisms and conditions.
CLO 4	Spectroscopic methods, including infrared spectroscopy (IR) and nuclear magnetic resonance (NMR), to identify and characterize organic compounds accurately.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-		2	-	-	40	-	60	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**-Continuous Evaluation, **ESE-** End Semester Examination

Course Name: Lab-II: Modern Physics
Course Code: 11204113
Prerequisite: basic idea of modern physics
Rationale: calculation related to modern physics

Course Learning Objective:

CLOBJ 1	Demonstrate Proficiency in Basic Laboratory Techniques
CLOBJ 2	Apply Theoretical Knowledge to Practical Situations
CLOBJ 3	Conduct Organic Synthesis and Reactions
CLOBJ 4	Use Spectroscopic Methods for Compound Identification.
CLOBJ 5	Practice Safe Laboratory Procedures.

Course Learning Outcomes:

CLO 1	Students will apply theoretical concepts from the Organic Chemistry lecture course to design and conduct experiments, demonstrating an understanding of the principles underlying reactions and synthesis.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Students will successfully carry out organic synthesis and reactions, producing desired products and demonstrating knowledge of reaction mechanisms and conditions.
CLO 4	Students will use spectroscopic methods, including infrared spectroscopy (IR) and nuclear magnetic resonance (NMR), to identify and characterize organic compounds accurately.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-		2	-	-	40	-	60	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

Semester 2

Course Name: Quantum mechanics
Course Code: 11204157
Prerequisite: basic information regarding matrices and fundamental quantum physics concepts
Rationale: To get the idea of modern atomic systems and various approximation methods

Course Learning Objective:

CLOBJ 1	Derive and understand the time-dependent and time-independent Schrödinger equations.
CLOBJ 2	Apply the Schrödinger equation to solve simple quantum mechanical problems.
CLOBJ 3	Master the mathematical representation of quantum operators and their properties.
CLOBJ 4	Apply operators to calculate expectation values and explore the evolution of quantum states.
CLOBJ 5	Study the quantum mechanics of angular momentum, including the eigenvalues and eigenstates of angular momentum operators.

Course Learning Outcomes:

CLO 1	Able to apply matrix method to solve Harmonic oscillator problem and will have knowledge about symmetries and conservation laws
CLO 2	Able to understand Schrodinger wave equation and its exact solution for One dimension
CLO 3	Able to apply Perturbation theory, variational methods and WKB methods for basic quantum mechanical
CLO 4	Able to analyze the treatment of 1d harmonic oscillator problem with use of operator and matrix formalism and will be Able to understand Transformations, conservation laws and Symmetries.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Unit 1**: **Matrix Formulation** Matrix addition and multiplication, Null, unit, and constant matrices, Trace, determinant, and inverse of a matrix, Hermitian and unitary matrices, Transformation and diagonalization of matrices, Functions of matrices, Matrices of infinite rank. Unitary matrix W, Transformation of the Hamiltonian with W, Transformation of the Hamiltonian with U, Transformation of the Hamiltonian with V, Representations of operators, Row and column matrices. Hilbert space, Dirac's bra and ketnotations, Projection operators, Physical meaning of matrix elements	25%	15
2	**Unit 2**: **SCHRODINGER WAVE EQUTION AND ITS EXACT SOLUTION FORONE DIMENSION :** (Review : admissibility condition for wave functions), Observables as dynamical variables and their expressions as Hermitian operator, general principle of uncertainty relations for non- commuting variables, Dirac delta function, solution of one dimensionalharmonic oscillator problem with the use of operator and matrix formalism. **SCHRODINGER EQUATION IN THREE DIMENSION:** Schrodinger equation in three dimensions, spherically symmetric different potentials, angular momentum, commutation amongst Lx, Ly and Lz ,eigen value spectrum of L2 and Lz, Legendre polynomials and spherical harmonics, bound state solutions for square well and Coulombic potential (H — atom).	25%	15

3	Unit 3: Approximation Methods for Stationary States : Perturbation Theory Perturbation theory for discrete levels, Equations in various orders of perturbation theory, Non - degenerate case, Degenerate case - removal of degeneracy, Effect of an electric field on the energy levels of an atom (Stark effect), Two - electron atoms. The variation method: Upper bound on ground state energy, Applications to excited states, Trial function linear in Variational Parameters, The Hydrogen molecule, Exchange interaction. WKB Approximation: One - dimensional Schrodinger equation, Bohr - Sommerfeld quantum condition, WKB solution of the radial wave equation.	25%	15
4	Unit 4: 1-D Harmonic Oscillator: treatment of 1D harmonic oscillator problem with use of operator and matrix formalism. Transformations, conservation laws and Symmetries: Translation in space and conservation of linear momentum, translation in time and conservation of energy, rotation in space, quantum generalization of the rotation operator and conservation of angular momentum, conservation of charge, reflection, parity and space inversion, Time- Reversal operator:- Properties of anti-linear operator, time reversal for spin less particle, time reversal operator for non-zero spin particle	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Introduction to Quantum mechanics (Third edition) David Griffiths and Darell F. Schroeter
2. Textbook of Quantum mechanics (Second edition) P. Mathews and Venkatesh
3. Modern Quantum mechanics (Third edition) J. J. Sakurai and J. Napolitano
4. Priciples of Quantum mechanics R. Shankar

Course Name: Electrodynamics

Course Code: 11204158

Prerequisite: Basic electrostatics and magnetostatics related knowledge

Rationale: to understand the electromagnetic waves and their applications

Course Learning Objective:

CLOBJ1	Able to understand applications of Maxwell's equations in the various fields.
CLOBJ2	Able to solve the Maxwell equations and apply for theory of dispersion.
CLOBJ3	Able to solve Electromagnetic wave equations and utilize the solution to explain the EM interaction with matter.
CLOBJ4	Able to explain the theory of wave guide and cavity.
CLOBJ5	Able to understand theory about the radiation fields of due to an accelerated and point charge.
CLOBJ6	Able to Utilize the knowledge to developed and design the various modes of resonator cavity and wave guide.

Course Learning Outcomes:

CLO 1	Able to understand applications of Maxwell's equations in the various fields.
CLO 2	Able to solve the Maxwell equations and apply for theory of dispersion.
CLO 3	Able to solve Electromagnetic wave equations and utilize the solution to explain the EM interaction with matter.
CLO 4	Able to explain the theory of wave guide and cavity.
CLO 5	Able to understand theory about the radiation fields of due to an accelerated and point charge.
CLO 6	Able to Utilize the knowledge to developed and design the various modes of resonator cavity and wave guide.

Teaching & Examination Scheme:

Teaching Scheme				**Examination Scheme**					
				Internal			**External**		**Total**
L	**T**	**P**	**C**	**T**	**CE**	**P**	**Theory**	**P**	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topi c	Weightag e	Teachin gHrs.
1	**Unit 1**: **EM WAVES IN MEDIUM AND THEIR DISPERSION** Maxwell's equations in matter, Maxwell's stress tensor, scalar and vector potentials, Gauge transformations, Lorentz and Coulomb gauges, Green's functions, Poynting theorem, plane wave and spherical wave solution of Maxwell's equations in infinite dielectric andconducting medium, skin depth, kinematics of dispersion and classicaltheory of dispersion, Normal and anomalous dispersion.	25%	15
2	**Unit 2**: **EM WAVE INTERACTION WITH DIELECTRICS** Reflection and Refraction of Electromagnetic Waves at a Plane Interface Between two Dielectrics, parallel and perpendicular polarization by reflection, Brewster's angle, Stoke's parameters, Totalinternal reflection, Fresnel's amplitude relations, Reflection and Transmission coefficients at normal and oblique incidence for interfaces between dielectric-dielectric and dielectric-metal	25%	15
3	**Unit 3**: **WAVE GUIDES AND RESONANT CAVITIES** Wave Guide and Resonant cavities, propagation of TM, TE and TEM modes in rectangular and cylindrical wave guides and cavities, Energyflow and power losses in wave guides and cavities, Q of a cavity, Coaxial cable, Earth and Ionosphere as a resonant cavity, Multimode Propagation in Optical Fiber Waveguides: H E Modes	25%	15
4	Unit 4: RADIATING SYSTEMS, MULTIPOLE FIELDS AND RADIATIONS Radiation from localized oscillating charges, Multipole Expansion of the EM Fields, Magnetic Dipole, Electric dipole and Quadrupole Fields and radiations, Centre- fed linear antenna, Radiation from an accelerated point charge, retarded potentials, Lienard-Wiechert potentials, Power radiated by a point charge : Lienard's formula and its nonrelativistic limit (Larmor's formula), Angular distribution and frequency spectrum of the radiation power	25%	15
	Total	100%	60

Text Book and Reference Book:

1. David Griffiths, Introduction to Electrodynamics
2. Halliday and Resnick, Physics
3. W. Saslow, Electricity, magnetism and light AICTE Model Curriculum for First Year

Course Name: Nuclear and Particle Physics

Course Code: 11204159

Prerequisite: basic idea about nucleus and elementary particles

Rationale: important to understand different nuclear phenomena and science with mechanism

Course Learning Objective:

CLOBJ 1	Understand the basic principles of nuclear structure and behavior. Comprehend the fundamental concepts of particle physics, including elementary particles and their interactions. Learn about nuclear reactions, including fusion and fission processes. Understand the principles of radioactive decay.
CLOBJ 2	Learn about different nuclear models (such as the shell model, liquid drop model) and their applications. Understand the nuclear forces and their role in determining nuclear structure. Apply quantum mechanics principles to describe nuclear phenomena. Understand the quantum mechanical structure of nuclei.
CLOBJ 3	Explore the properties of elementary particles, including their masses, spins, and charges. Understand the classification of particles into hadrons and leptons.
CLOBJ 4	Familiarize yourself with experimental methods used in nuclear and particle physics. Gain hands-on experience in using detectors and accelerators.
CLOBJ 5	Explore symmetries and conservation laws in particle physics. Understand the significance of symmetries in the behavior of particles.

Course Learning Outcomes:

CLO 1	Able to understand Fundamentals of nuclear properties and their interaction in core level.
CLO 2	Able to understand and categorizing the theory of nuclear model and nuclear decay.
CLO 3	Able to analyze various nuclear reactions and creating one of such based-on core theoretical concepts.
CLO 4	Able to illustrate different particle detectors and accelerators by understanding the fundamental theory nuclear fission and fusion reaction.
CLO 5	Able to apply ethical principles to create and develop the energy generation solution.
CLO 6	Able to classify different elementary particles and collaborating with the recent applications.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topi c	Weightag e	Teachin gHrs.
1	**Unit 1**: **Nuclear Properties and Nuclear Interaction:-** Nuclear Properties: - Introduction, constituents of nucleus and their intrinsic properties, angular momentum, electric and magnetic moment,electric quadrupole moment of nucleus, wave mechanical properties ofnucleus, Nuclear binding energy, Nuclear force, Meson theory of nuclear force, e.g. Bartlett, Heisenberg, Majorana forces and potentials, Exchange forces, Tensor forces, Theory of spin dependence of nuclear force, Charge independence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction. Nuclear Interactions: - Two body problems, deuteron problem, bindingenergy, nuclear potential well, p-p and p-n scattering at low energy.	25%	15
2	Unit 2: Nuclear Model and Nuclear decay & Reaction: - Nuclear Models: Semi-empirical mass formula and its applications, Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell effects, Shell Model, Spin-Orbit interaction and Magic numbers, Quantitative discussion and estimates of transition rates, magnetic moments and Schmidt lines, Collective nuclear model, Ground state spins of odd-odd nuclei (Nordheim's rule). Applications of Shell model like Angular momenta and parities of nuclear ground states, prediction, Selection rules, Nuclear decay & reaction: - Theories for α, β and Y decay, transition probabilities, Comparative half-lives, Allowed and forbidden transitions, selection rules, Reactor physics: fission reactors, Schemes for nuclear fusion. Gamma decay, Multipole transitions in nuclei, Nuclear reactions: - Partial wave analysis, Resonance scattering and reaction- cross section for a nuclear reaction, Differential cross section, Q-value of reaction, threshold energy, Nuclear isomerism. Reciprocity theorem, Breit Wigner one level formula.	25%	15

3	Unit 3: Particle Detector and Accelerators- Gas filled counters- Characteristic and principle of gas filled detector, Proportional counter, G.M. Counter, Efficiency of detection, scintillator counters, solid state detectors, surface barrier detectors, Semiconductor detectors- the semiconductor junction, the depletion depth, reverse biased junctions, Silicon diode detectors. Nuclear emulsion techniques. Accelerators - Acceleration of charged particles, Van de Graaff accelerator, Tandem accelerators, Linear accelerators, Proton synchrotron, Particle accelerator, Acceleration of heavy ions, Cyclotron, Synchrocyclotron and their applications.	25%	15
4	Unit 4: Elementary Particles Physics and Nuclear Astrophysics: Elementary Particles Physics and Nuclear Astrophysics: Types of interactions between elementary particles, Standard model for elementary particles, Quarks, hadrons, Baryons and leptons, Strange particles, conservation of strangeness in strong interactions, Baryon number conservation, lepton number conservation, Lepton family, Gell- Mann Nishijima formula, Eight-fold way (qualitative only), Quark model, quark content of baryons and mesons, color degree of freedom, Detection of neutrinos. Three generations of neutrinos. Symmetries and conservation laws of energy, momentum, angular momentum, charge and isospin, parity symmetry, Violation of parity in week interactions, Conjugation symmetry, CP violation in week interactions. Elementary ideas of CP and CPT invariance. Nuclear Astrophysics- Introduction to black holes, Big bang theory, Hot Big-Bang cosmology, Primodial and Stellar nucleosynthesis, Interactions of particle and nuclear in the early universe.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Nuclear and Particle Physics An introduction by B. R. Martin
2. Nuclear and Particle Physics An introduction by Satadal Bhattacharya
3. Particle Physics by Bipin Ghosh
4. Introduction to Nuclear and Particle Physics by Saverio D'Auria

Course Name: Electronics-II

Course Code: 11204160

Prerequisite: introduction of semiconductor materials and devices
Rationale: applications in modern electronics and programming the circuits

Course Learning Objective:

CLO 1	Able to understand and to apply the knowledge of various semiconductor electronic devices like Field effect devices, Heterojunction and homogenous semiconductor devices etc. in practice.
CLO 2	Able to apply the concepts of various optoelectronic devices and microprocessor in various real life electronic appliances and technology
CLO 3	Able to understand the basic concepts of Counters and registers, K-mapping, Boolean algebra etc. which will be helpful to create any innovative idea in the field of digital electronics
CLO 4	Able to understand the use of waveguide in microwave communication devices. They will be also able to create the innovative thinking in their minds after detail study of RADAR and its applications.

Course Learning Outcomes:

CLO 1	Able to understand and to apply the knowledge of various semiconductor electronic devices like Field effect devices, Heterojunction and homogenous semiconductor devices etc. in practice.
CLO 2	Able to apply the concepts of various optoelectronic devices and microprocessor in various real life electronic appliances and technology
CLO 3	Able to understand the basic concepts of Counters and registers, K-mapping, Boolean algebra etc. which will be helpful to create any innovative idea in the field of digital electronics
CLO 4	Able to understand the use of waveguide in microwave communication devices. They will be also able to create the innovative thinking in their minds after detail study of RADAR and its applications.

Teaching & Examination Scheme:

Teaching Scheme				**Examination Scheme**					
				Internal			**External**		
L	**T**	**P**	**C**	**T**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	**Topic**	**Weightage**	**Teaching Hrs.**

1	**Unit 1**: **SEMICONDUCTOR ELECTRONIC DEVICES** Metal-Semiconductor Contact, Field effect devices, Heterojunction andhomogenous semiconductor devices: Construction, working and characteristics, Characteristics and applications as half wave and full wave rectifier, SCR, TRIAC and DIAC — structure, working, characteristics and applications. Filter circuits: first order and second order filter, band pass and band reject filters, Notch filters.	25%	15
2	**Unit 2**: **OPTOELECTRONIC DEVICES AND MICROPROCESSOR** Tunnel diode, Photonic Devices: Photoconductive sensors-Junctiontype photoconductors: (a) PN photodiodes (b) PIN photodiodes (c) Avalanche photodiode (d) NPN photo diode (e) phototransistors andapplications, Parallel Binary adder/substractor Introduction to Microprocessor 8085, A programmable machine: device, Memory, Input/output, CPU, Block diagram of Microcontroller,Organization of Microprocessor-Based system, Application of Microprocessor: Microprocessor controlled Temperature system (MCTS)	25%	15
3	Unit 3: DIGITAL ELECTRONICS Counters and registers, Synchronous counters, Design of counters of different modulus-Shift registers and their applications, Combinational Logic Review of Boolean identities and its use to minimize Boolean expressions, Sequential Logic, K-mapping, Solution of Boolean expression of the ranks: 3, 4 and 5 using K-mapping. 4-bit serial, parallel and combinational counter, Semiconductors memories: ROM, EPROM, EEPROM-Static and Dynamic RAM.	25%	15

4	Unit 4: ELECTONICS COMMUNICATION Wave Guides: Maxwell's equations for rectangular waveguides, transverse magnetic waves in rectangular waveguide and transverse electric waves in rectangular waveguide. power transmission and power losses in waveguide. Radar Radar system, basic principles, fundamentals, radar performance factors, Pulsed systems, Basic pulse Radar system, Moving target indication (MTI), Radar Beacons, CW Doppler radar, FM CW radar.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Semiconductor Optoelectronic Devices (TextBook) P. Bhattacharya; Prentice Hall of India (1997)
2. Semiconductor Optoelectronics J. Singh; McGraw-Hill Inc, 1995
3. Semiconductor Devices: Physics and Technology S. M. Sze; Wiley, 2008
4. Photonics: Optical Electronics in Modern Communications A. Yariv and P. Yeh; Oxford University Press, New York (2007)
5. Fundamentals of Photonics B. E. A. Saleh and M. C. Teich; John Wiley & Sons

Course Name: Thermodynamic and statistical Physics

Course Code: 11204161

Prerequisite: Fundamental laws of thermodynamics

Rationale: for understanding different physical systems and mechanism of thermodynamics

Course Learning Objective:

CLOBJ 1	To make the students understand the concepts laws of thermodynamics its applications and phase equilibria.
CLOBJ 2	To use the knowledge of thermodynamics in various applications in allied fields like Materials science, Condensed matter Physics, Atmospheric Physics, Solar Physics, etc.
CLOBJ 3	To learn the different types of statistics distribution, probability distribution laws for particles in various systems.
CLOBJ 4	To provide the basic idea of probability and calculating probability for various statistical systems of particles.
CLOBJ 5	To describe the features and examples of Maxwell-Boltzmann, Bose Einstein and Fermi Dirac statistics.

Course Learning Outcomes:

CLO 1	Able to understand the fundamentals of thermodynamics, Carnot cycle, statistics and distributions.
CLO 2	Able to Explain the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws.
CLO 3	Able to understand the application Ising model and mean field theory for first and second order phase transitions.
CLO 4	Able to analyze important examples of ideal Bose systems and Fermi systems.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **CE-** Continuous Evaluation

Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Unit 1**: **THERMODYNAMICS**: Macroscopic and microscopic system, Extensive and intensive variables,Thermal equilibrium, Laws of thermodynamics and their consequence, Applications based on the thermodynamics laws, Entropy: Reversible and Irreversible processess, Carnot's cycle, engine and its efficiency, Enthalpy, Thermodynamic potentials and Maxwell's relations. Probability and Kinetic theory: Probability densities, Relation between statistics and thermodynamics, Classical ideal gas, Ideal gas equation and their consequence. Specific heat andentropy of perfect gas.	25%	15

2	Unit 2: STATISTICAL MECHANICS: Classical Statistical Mechanics: Postulates of classical statistical mechanics, Liouville's theorem and its consequences, Equipartition and virial theorems, Ideal gas in canonical and grand canonical ensemble. Partition function, partition function of an ideal monatomic and diatomic gas. Quantum Statistical Mechanics: Quantum-mechanical ensemble theory, Introduction to density matrix and its applications, Boltzman statistics, Quantum distribution function, Bose-Einstein statics, Fermi dirac Statics, Statistics of the occupation numbers, Statistical mechanics of Bosons, Fermions,	25%	15
3	Unit 3: PHASE TRANSITION Blackbody radiation and Planck's law of radiation, Magnetic behavior of an ideal Fermi gas, Diamagnetism, Paramagnetism, Phase Space, Phase space densities, The Boltzmann equation, transport phenomena of phase transition, Different order of phase transitions, Quantization of harmonic oscillator andcreation and annhilation of phonon operators, Quantization of fermion operators. Ising model, the Bragg-William approximation, Ising models: 1-dimension,2-dimension and 3- dimension.	25%	15
4	Unit 4: Application of STATISTICAL MECHANICS: Fluctuations of energy and density in canonical and grand-canonical ensemble. Applications of Bose-Einstein (BE) statics to BE condensation, Application of Fermi-Dirac statics: Pauli Paramagnetism, theory of white dwarfs, Liquid helium and its properties, System of interacting Bosons	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Thermodynamics and Statistical Mechanics by Richard FItzpatrick
2. Statistical thermodynamics by Terell L. Hill

Course Name: Lab-I
Course Code: 11204162
Prerequisite: basic electronic concepts
Rationale: logic gates and their applications
Course Learning Objective:

CLOBJ 1	Demonstrate Proficiency in Basic Laboratory Techniques
CLOBJ 2	Apply Theoretical Knowledge to Practical Situations
CLOBJ 3	Conduct Organic Synthesis and Reactions
CLOBJ 4	Use Spectroscopic Methods for Compound Identification.
CLOBJ 5	Practice Safe Laboratory Procedures.

Course Learning Outcomes:

CLO 1	Students will apply theoretical concepts from the Organic Chemistry lecture course to design and conduct experiments, demonstrating an understanding of the principles underlying reactions and synthesis.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Students will successfully carry out organic synthesis and reactions, producing desired products and demonstrating knowledge of reaction mechanisms and conditions.
CLO 4	Students will use spectroscopic methods, including infrared spectroscopy (IR) and nuclear magnetic resonance (NMR), to identify and characterize organic compounds accurately.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
4	**-**		**2**	**-**	**-**	**40**	**-**	**60**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

Course Name: Lab-II
Course Code: 11204163
Prerequisite: computer programming
Rationale: applications of different software in theoretical physics
Course Learning Objective:

CLOBJ 1	Demonstrate Proficiency in Basic Laboratory Techniques
CLOBJ 2	Apply Theoretical Knowledge to Practical Situations
CLOBJ 3	Conduct Organic Synthesis and Reactions
CLOBJ 4	Use Spectroscopic Methods for Compound Identification.
CLOBJ 5	Practice Safe Laboratory Procedures.

Course Learning Outcomes:

CLO 1	Students will apply theoretical concepts from the Organic Chemistry lecture course to design and conduct experiments, demonstrating an understanding of the principles underlying reactions and synthesis.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Carry out organic synthesis and reactions, producing desired products and demonstrating knowledge of reaction mechanisms and conditions.
CLO 4	Spectroscopic methods, including infrared spectroscopy (IR) and nuclear magnetic resonance (NMR), to identify and characterize organic compounds accurately.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-		2	-	-	40	-	60	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

Course Name: Seminar
Course Code: 11204164

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Proficiency in the theoretical aspects of various instrumental techniques employed in analytical chemistry, such as spectroscopy, chromatography, and electrochemical methods.
CLO 2	Acquire theoretical competence in quantitative analysis, including the understanding of statistical methods and mathematical models applied to analyze experimental data and determine concentrations accurately.
CLO 3	Develop the ability to apply theoretical concepts to analyze molecular structures, elucidate chemical mechanisms, and interpret spectroscopic data to identify functional groups and molecular arrangements.
CLO 4	Understand the theoretical principles involved in designing and optimizing analytical methods, taking into consideration factors such as sensitivity, selectivity, and robustness for effective chemical analysis.
CLO 5	Develop strong theoretical foundations for interpreting complex analytical data, applying critical thinking skills to draw conclusions, make predictions, and evaluate the reliability and precision of experimental results.
CLO 6	Attain a conceptual understanding of analytical error sources, uncertainty propagation, and statistical treatment of uncertainties, enabling the critical assessment of measurement reliability and the implementation of error

	reduction strategies in analytical processes.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
0	2	0	2	-	-	-	50	-	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Semester - 3

Course Name: Advanced Quantum Mechanics
Course Code: 11204207
Prerequisite: fundamental of quantum mechanics
Rationale: understanding scattering mechanism and angular momentum

Course Learning Objective:

CLOBJ 1	Derive and understand the time-dependent and time-independent Schrödinger equations.
CLOBJ 2	Apply the Schrödinger equation to solve simple quantum mechanical problems.
CLOBJ 3	Master the mathematical representation of quantum operators and their properties.
CLOBJ 4	Apply operators to calculate expectation values and explore the evolution of quantum states.
CLOBJ 5	Study the quantum mechanics of angular momentum, including the eigenvalues and eigenstates of angular momentum operators.

Course Learning Outcomes:

CLO 1	Able to understand how scattering amplitude and scattering cross-section are related to each other. They will be Able to also analyze the findings of scattering cross-section using partial wave analysis and Born approximation techniques
CLO 2	Able to apply the Matrix Representation of Angular Momentum and Pauliâ•Žs spin matrices and their algebra to various quantum mechanics based problems.
CLO 3	Able to apply the knowledge of creation, annihilation and number operators in the field of quantization.
CLO 4	Able to analyze the need of relativistic quantum mechanics. They will be also Able to understand the Klein Gordon equation and its limitations.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Scattering Theory:**: Kinematics of the scattering process : differential and total cross sections elastic and inelastic scattering, wave mechanical picture of scattering : the scattering amplitude, Green's functions : formal expression for scattering amplitude. The Born approximation, validity of the Born approximation, The Born series, The Eikonal approximation, Asymptotic behavior of partial waves: phase shifts, The scattering amplitude in terms of phase shift, The differential and total cross sections: optical theorem, Phase shifts: Relation to the potential, Potentials of finite range, Low energy scattering, scattering by a squarewell potential, scattering by a hard sphere, scattering by a coulomb potential, Complex potential and absorption.	25%	15
2	**Angular Momentum:**: Matrix Representation of Angular Momentum, Pauli's spin matricesand their algebra, Addition of angular moment, Simple examples. Coupling of two angular momenta and C.G. Coefficients for J1=1/2, J2=1/2, and J1=1, J2=1/2.Many Electron Atom: Central field approximation, Hartree method of self-Consistent fields, Ground statesof He atom, Hartree-Fock methods: Ortho and Para states of He.	25%	15

3	Quantization of Fields:: Classical radiation fields, Fourier decomposition and radiation oscillators, creation, annihilation and number operators, quantization of radiation oscillators, quantized radiation fields, photon states, quantization of non-relativistic Schrödinger wave equations for Bosons as well as for Fermions, Matrix representation of creation, annihilation and number operators and their states for Fermions.	25%	15
4	Relativistic wave equations: Generalization of the Schrödinger equation, the Klein-Gordon equation and its plane wave solutions. Dirac's relativistic Hamiltonian and the Dirac equation, position probability density and expectation values, Dirac matrices, plane wave solution of the Dirac equation, the spin of the Dirac particles, significance of the negative energy states, Relativistic electron in central potential, electron in magnetic field and spin magnetic moment.	25%	15
	Total	100%	60

Text Book and Reference Book:
1. Introduction to Quantum mechanics (Third edition) David Griffiths and Darell F. Schroeter
2. Textbook of Quantum mechanics (Second edition) P. Mathews and Venkatesh
3. Modern Quantum mechanics (Third edition) J. J. Sakurai and J. Napolitano
4. Priciples of Quantum mechanics R. Shankar

Course Name: Computational Techniques in Physics

Course Code: 11204208

Prerequisite: Programming, arithmetic calculations in physics

Rationale: important in developing computer programming for various theoretical calculations

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Able to Understand the importance of computational techniques for solving a broad range of complex problems involving fluids, solids, waves, quantum systems, as well as biological and social systems with internal degrees of freedom (psycho-physics).
CLO 2	Able to Understand the problem statement and Able to solve by using direct and indirect method
CLO 3	Able to Demonstrate understanding of common numerical methods and how they are used to in approximate solutions to otherwise intractable mathematical problems.
CLO 4	Able to derive the numerical problems.
CLO 5	Able to understand the impact of risk and uncertainty in prediction and forecasting models.
CLO 6	Able to handle the problems that promotes a better physics understanding for a majority of the students.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme		
L	T	P	C	Internal	External	Total

				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topi c	Weightag e	Teachin gHrs.
1	**Introduction to Computational Physics:**: Need and advantages of high level language in physics, programming in a suitable high level language (Matlab/Mathematica/Scilab/Octave), input/output, interactive input, loading and saving data, loops branchesand control flow, Matrices and Vectors, Matrix and array operations, Graphic tools: Gnuplots, Origin, Sigmaplot, Visual Molecular Dynamics, Mathematica, etc	25%	15
2	**Numerical Linear Algebra & Introduction to Scientific Computing:**: Representation of numbers in computers; programming languages, compiled vs interpreted languages; errors, accuracy and stability in computation, basics of Python programming language. Basic Numerical Methods with application to Physics: Numerical Root Finding: Bisection, secant and Newton-Raphsonmethods. Interpolation and Differentiation: Linear and spline interpolation,numerical differentiation.	25%	15
3	Basic Numerical Methods with application to Physics:: Integration: Trapezoidal, Simpson's and Gaussian quadratures methods. Differential Equations: Euler, second and fourth order Runge-Kutta methods, Verlet, midpoint method, implicit and explicit finite difference methods, Crank-Nicolson scheme, Gaussian elimination, LU decomposition methods	25%	15

4	Computational Methods in Physics & DFT: Monte-Carlo Techniques: Random number generation, Monte-Carlo integrations, Metropolis algorithm, application to 2D-Ising model Discrete Fourier Transform: Discretely sampled data, fast Fourier transform (FFT), convolution and deconvolution, correlation and autocorrelation, sampling theorem, DFT and its applications Parallel and GPU Computing: Introduction to OpenMP, MPI and pyCUDA.	25%	15
	Total	100%	60

Text Book and Reference Book:
1. Computational Methods In Physics 2018 Edition by Simon Sirca, Martin Horvat.
2. Computational Methods in Physics and Engineering By Samuel S M Wong

Course Name: Materials Science
Course Code: 11204209
Prerequisite: basics in material science and properties
Rationale: understanding material mechanisms and synthesis processes

Course Learning Objective:

CLOBJ 1	To understand and distinguish between variety of materials based on their structure and properties.
CLOBJ 2	To gain knowledge of various polymer processing techniques, the fabrication of different types of composites, ceramics, glasses and their applications.
CLOBJ 3	To understand about various phase transformations by using phase equilibrium diagram in different alloys system.
CLOBJ 4	To understand the Density functional theory (DFT)-a quantum-mechanical (QM) method used in chemistry and physics (i) To calculate the electronic structure of atoms, molecules and solids. (ii) To predict the electronic structure, chemical bonding, and other properties of materials, such as their band gap, magnetic moment, and optical properties.
CLOBJ 5	To introduce various engineering alloys and their applications as an advance material.

Course Learning Outcomes:

CLO 1	Able to Identify the properties of metals with respect to crystal structure and grain

	size
CLO 2	Able to Classify and distinguish different types of cast irons, steels and non-ferrous alloys
CLO 3	Able to Interpret the phase diagrams of materials. Explain the powder metallurgy process, types and manufacturing of composite materials
CLO 4	Able to understand the Concepts on formatting, rounding off rules and errors. Different numerical techniques utilized in programming. Students are expected to perform & learn computation of data by using different numerical methods.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Materials and Defects**: Introduction to engineering materials, Description of materials science,Force - interatomic distance curve, Crystalline and Amorphous materials structures, Crystal imperfections, Significance of structure property correlations in all classes of engineering materials. Defects and Diffusion phenomenon: Defects-types of defects, motion and properties of dislocation, Diffusion in solids, Kirkendall effect, Rate andmechanism of diffusion, Fick’s first and second law of diffusion, solutions to Fick’s second law, Applications of diffusion, Concept of uphill diffusion, atomic theory of diffusion, mechanism of diffusion.	25%	15

2	**Properties of materials and Ceramics**: Properties of materials- mechanical properties of materials- elastic andplastic deformation, hardness, dislocations and strengthening mechanisms, failure-fatigue and creep, corrosion and degradation of materials- corrosion rates, forms of corrosion, passivity, corrosion prevention, oxidation. Special materials and their properties- ceramics-crystal structures, Classification of ceramics, advanced ceramic materials -silicate ceramics, glass ceramics and polymers, glass transition, polymerization, composites- particle and fiber reinforced composites,ferrous and non-ferrous alloys, Applications of special materials in advanced technologies	25%	15
3	Phase diagram and Phase Transformations: Phase diagrams: - Basic definitions; Gibbs phase rule, Introductions- binary phase diagrams, binary isomorphous systems, binary eutectic systems, ternary and quaternary system, Construction of binary isomorphous diagram from cooling curves, Time scale for phase diagrams. Phase transformations: - types of transformations, homogeneous and heterogeneous transformation, thermodynamics of transformation, nucleation and growth kinetics, overall kinetics, recovery, recrystallization and grain growth.	25%	15
4	Computational Material Science: Introduction to computational modelling and simulation for Materials Science, First principle methods: Molecular mechanics- Force Field Methods, Early first principles calculation, Born-Oppenheimer approximation, Hartree method (one electron), Hartree- Fock molecular orbital theory, Self-consistent-field (SCF) procedure. Density functional theory (DFT): electron density in DFT, Hohenberg- Kohn theorems, Kohn-Sham approach, exchange correlation functionals, solving Kohn-Sham equations, DFT extensions and limitations. Molecular dynamics (MD): Atomic model in MD, Molecular mechanics, potentials, solutions for newton’s equation of motion, steepest descent method, conjugate gradients method.	25%	15

		Total	100%	60

Text Book and Reference Book:
1. Material Science and Engineering by William Callister
2. Introduction to Materials Science for Engineers by James Shackelford
3. Elements of Materials Science and Engineering (Addison-Wesley Series) by L H Van Vlack

Course Name: Classical Electrodynamics and Plasma Physics
Course Code: 11204210
Prerequisite: Newton's laws of motion and basics in classical physics
Rationale: plasma physics and electrodynamics

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

a. **Course Learning Outcomes:**

CLO 1	Able to gain knowledge about the Maxwells equations and utilize the solution of Maxwells equation in time varying field.
CLO 2	Able to understand the relativistic theory and apply the special theory of relativity to solve the electrodynamics related problems.
CLO 3	Able to explain the phenomena of Plasma.
CLO 4	Able to explain the hydro dynamical description for Plasma.

CLO 5	Able to apply the plasma theory for to solve the problems of flow of wave as well as fluids.

Teaching & Examination Scheme:

Teaching Scheme				**Examination Scheme**					
L	**T**	**P**	**C**	**Internal**			**External**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	**Topic**	**Weightage**	**Teaching Hrs.**
1	**Time varying fields and Maxwell equations:**: Faraday's law of induction, displacement current, Maxwell equations,scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.	25%	15
2	**Relativistic electrodynamics**: Equation of motion in an electromagnetic field; Electromagnetic field tensor, covariance of Maxwells equations; Maxwell's equations as equations of motion; Lorentz transformation law for the electromagneticfields and the fields due to a point charge in uniform motion; Field invariants; Covariance of Lorentz force equation and the equation of motion of a charged particle in an electromagnetic field; The generalised momentum; Energy-momentum tensor and the conservation laws for the electromagnetic field; Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.	25%	15
3	**Plasma:**: Plasma State, elementary concepts and definitions of temperature andother parameters, occurrence and importance of plasma for various applications, Production of Plasma in the laboratory, Physics of glow discharge, electron emission, ionization, breakdown of gases, Paschen's laws and different regimes of E/p in a discharge, Townsenddischarge and the evolution of discharge.	25%	15

4	Hydrodynamical description of plasma:: Fundamental equal ions, hydrodynamic waves, magnetosonic Alfven waves, Wave phenomena in magneto plasma, polar izat ion, phase velocity, group velocity, cut-offs, resonance for electromagnetic wave propagating parallel and perpendicular to the magnetic field, Appleton- Hartee formula and propagate ion through ionosphere and magnetosphere	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Classical Electromagnetism by H. C. Verma
2. Introduction to Classical Electrodynamics by Lim Y K
3. Introduction to Plasma Physics and Controlled Fusion by Francis F. Chen

Course Name: Condensed Matter Physics

Course Code: 11204211

Prerequisite: material science and basics of crystallography

Rationale: understand the study of phase transformation and different special properties of materials

Course Learning Objective:

CLOBJ 1	Describe and interpret phase diagrams of soft matter systems, including polymer blends, colloids, and liquid crystals. Predict the stable phases present at different temperatures and pressures. Analyze the influence of molecular interactions and composition on phase behavior.
CLOBJ 2	Explain the mechanisms of phase separation in soft matter, including spinodal decomposition and nucleation growth. Derive and apply models for describing the kinetics of phase separation. Predict the growth rates and characteristic length scales of evolving phases.
CLOBJ 3	Analyze the dynamics of crystallization and melting in soft matter materials. Discuss the role of surface tension, diffusion, and kinetic barriers in these processes. Understand the influence of confinement and external fields on growth patterns.
CLOBJ 4	Classify different types of liquid crystals based on molecular structure and order parameters. Identify and characterize liquid crystal phases using optical and scattering techniques. Understand the relationship between orientation order, elastic properties, and phase transitions in liquid crystals.
CLOBJ 5	Explain the relationship between polarizability, dielectric constant, and phase behavior in soft matter. Analyze the effect of alternating fields on liquid crystals and other soft materials. Investigate the dielectric response of non-polar and polar solids, including

	ferroelectric systems. Understand the principles of photoconductivity and photovoltaic energy conversion in soft matter.

Course Learning Outcomes:

CLO 1	Able to understand the concepts on Phase transitions. Citing the kinds of liquid crystals and developing one of such kind by evaluating the principles and theories
CLO 2	Able to understand the concepts of dielectrics and ferroelectrics. Prioritizing articulation in industrial field.
CLO 3	Able to Recognize the optical properties. Solving pre justified models on devices working on optical properties.
CLO 4	Able to classify of lattice dynamics. Predicting lattice dynamics based on theories and analysing results with various research papers.
CLO 5	Able to design a project work in a team for innovative used some ideas to develop a modern technology.
CLO 6	Able to Utilize the theory to solve and design the modified the properties of materials for future applications
CLO 7	Able to Categorize few of them from research point of view.

Teaching & Examination Scheme:

Teaching Scheme				**Examination Scheme**					
				Internal			**External**		**Total**
L	**T**	**P**	**C**	**T**	**CE**	**P**	**Theory**	**P**	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C-** Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	**Topic**	**Weightage**	**TeachingHrs.**

1	**Phase transition and Liquid Crystals**: **Phase Transitions** Review of critical phenomena through percolation. Phase transition in soft matter. Equilibrium phase diagrams, Kinetics of phase separation,Growth processes, Liquid-Solid transition, freezing and melting **Liquid Crystals** Types of liquid crystals, Characterization and identification of liquid crystal phases, Orientation order, elastic properties, Phase transition inliquid crystals, Applications	25%	15
2	**Dielectrics & Ferroelectrics**: **Dielectrics**: Polarizability and its dependence on frequency, dielectricconstant and dielectric loss, effect of alternating fields, complex dielectric constants of non-polar solids, dipolar relaxation, energy absorption and losses, some important insulating materials **Ferroelectrics**: ferroelectric crystals classification, displacive transitions, Landau theory of phase transition, first and second ordertransition, antiferroelectricity, ferroelectric domains and imaging.	25%	15
3	Optical Properties & Plasmon: Optical properties: Propagation of light in conducting media, Drude model, absorption processes, exciton absorption, free carrier absorption, absorption processes involving impurities, photoconductivity, response time and gain factor, p-n junction photovoltaic cells, characteristics and applications, photovoltaic detectors. Plasmon: Experimental observation of plasmons in solids : characteristics energy-loss experiments	25%	15

4	Lattice dynamics: Classical theory of lattice vibrations in 3-dimensions under harmonic approximation; Dispersion relation: acoustical and optical, transverse and longitudinal modes; Lattice vibrations in a monatomic simple cubic lattice; Symmetry consideration of eigen vectors; Frequency distribution function; Maxima, minima and Saddle points; Frequency variation close to the critical points, Normal coordinates and phonons; Occupation number representation of the lattice Hamiltonian, Phonon- Phonon interaction; Neutron diffraction by lattice vibrations; Coherent and incoherent scattering, scattering cross section for one phonon, multi phonon processes, Debye - Waller factor; Atomic displacement and melting point; Thermal conductivity in insulators; Mossbauer effect.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Condensed Matter Physics by Michael P. Marder
2. Optical Properties of Condensed Matter and Applications by Jai Singh
3. Condensed Matter Physics by Gert R. Strobl

Course Name: Nanostructured materials and its applications
Course Code: 11204212
Prerequisite: Information regarding nano technology
Rationale: synthesis of nanomaterials at research level and understanding the properties

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.

CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Able to Identify the properties of metals with respect to crystal structure and grain size
CLO 2	Able to Classify and distinguish different types of cast irons, steels and non-ferrous alloys
CLO 3	Able to Interpret the phase diagrams of materials. Explain the powder metallurgy process, types and manufacturing of composite materials
CLO 4	Able to understand the Concepts on formatting, rounding off rules and errors 3. Different numerical techniques utilized in programming. Students are expected to perform & learn computation of data by using different numerical methods.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
				Internal			External		Total
L	T	P	C	T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topi c	Weightag e	Teachin gHrs.

1	**Introduction of Nanostructured materials**: Nanomaterial-Introduction about Nanomaterials, Classification of Nanomaterials-0D, 1D, 2D and 3D nanostructured material, Size andshape dependant properties and their uniqueness; Energy at nanoscale, Surface characteristics and electrostatic and steric stabilization. Quantum confinement, Amorphous and crystalline nanomaterial, Crystal structure identification and lattice parameters.	25%	15
2	**Types of nanomaterials**: Types of nanomaterials; Organic and inorganic nanomaterial, Functional nanomaterials, Hybrid nanomaterials – core-shells, nanoshells, self-assembled nanostructures, super lattices, nanoceramics metallic, polymeric and ceramic nanocomposites, nanoporous materials, nanofluids, nanolayers and carbon based nanomaterials; carbon nanotubes (CNT- SWCNT, MWCNT), Fullerenes	25%	15
3	**Properties of Nanostructure materials**: Physical, Structural, chemical, electrical, dielectric, optical and magnetic properties of nanomaterials such as; metal nanoparticles,Semiconductor nanostructures, Oxide nanomaterials of metal & semiconductor, ceramic and carbon based nanomaterials	25%	15
4	Application of Nanomaterials: Nanomaterials as sensors- biosensors, Gas sensors, Nanosensors, Application of nanotechnology in energy, memory applications, Solar energy, Nanomaterials in Optical application, luminescence, optoelectronics, electronics, Medicine, Environmental health and safety issues.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Nanoscience and Nanotechnology: Fundamentals of Frontiers by Shubra Singh M.S. Ramachandra Rao
2. Principles of Nanoscience and Nanotechnology by M.A. Shah
3. Nanosciecne and nanotechnology by PB.Choudhary K K

Course Name: Luminescence

Course Code: 11204213

Prerequisite: Optical properties of semiconductors and basics of atomic structures

Rationale: understanding luminescence mechanism for different materials

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Able to Create models to better comprehend solid matter's physical properties.
CLO 2	Able to Examine the approximations required to construct models in order to comprehend the solid state.
CLO 3	Able to Understand the classical and quantum mechanical laws that can be used to explain solid-state phenomena.
CLO 4	Able to Formulate and comprehend hypotheses that describe solid-state phenomena.
CLO 5	Able to Understand how solid state physics has influenced major technology advancements.

Teaching & Examination Scheme:

Teaching Scheme				**Examination Scheme**					
				Internal			**External**		**Total**
L	**T**	**P**	**C**	**T**	**CE**	**P**	**Theory**	**P**	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C-** Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	**Topi c**	**Weightag e**	**Teachin gHrs.**
1	**General Concept of Luminescence:**: Classification of Luminescence, Fluorescence and Phosphorescence, Mechanism of Fluorescent and Phosphorescent Emission. Concept of Thermoluminescecen Factors influencing the luminescence and Thermoluminescecen (TL). Application of TL in Archaeology, Geology, Quality Control in Industry, Forensic Science, Biology, Biochemistry and Radiation dosimetry.	25%	15
2	**Understanding of Phenomenon:**: By Band Theory of Solids, By Configurational Coordinate Diagrams,By the Physico-Chemical Effects Produced. **Mathematical Treatment of the TL Problem:** (i) Detrapping of Charge Carriers from Metastable Levels. (ii) Simple Theory of Randall& Wilkins. (iii) Kinetic Equations and Solutions. (iv) Statistical Model/Fermi Level Analysis. (v) TL Growth Curve Equations **Experimental Methods of determining the TL parameters:** Initial Rise Method, Method Using Different Heating Rates, Method Based onGlow Curve Shape, Inflection-Point Method, Isothermal Decay Method,Area Measurement Method, Curve-Fitting Method, Fermi Level Analysis	25%	15

3	Factors affecting on TL:: Effect of Impurities, Effect of Thermal Treatments, Effect of Irradiation Dose, Effect of LET of Irradiation, Effect of UV Rays, Effect of Stress, Crystallisation and Particle Size, Storage Effects, Thermal Quenching Effects, Electrostatic Effects, Effect of IR Stimulation Luminescence Instrumentation: TL/OSL reader, Fluorescent Reader, Mechanism of OSL. Mathematical Model for OSL. Photoluminescence, Theory and Applications and Electroluminescence.	25%	15
4	Luminescent Material: (Phosphors), Details of phosphors preparation techniques, Application of Luminescent Material(Phosphors); (i) TV, (ii) CRO, (iii) EL panel devices and (iv) Lamp phosphors [TL, CFL, HPMV and HPSV], their preparation, properties and limitations.	25%	15
	Total	100%	60

Text Book and Reference Book:
1. Luminescence: From Theory to Applications by Cees Ronda
2. Luminescent Materials and Applications by Adrian Kitai

Course Name: Physics of Renewable energy
Course Code: 11204214
Prerequisite: Sources of energy and importance
Rationale: Important to understand the renewable sources of energy

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Knowledge about the Maxwell's equations and utilize the solution of equation in time varying field.
CLO 2	Able to understand the relativistic theory and apply the special theory of relativity to solve the electrodynamics related problems.
CLO 3	Able to explain the phenomena of Plasma.
CLO 4	Able to explain the hydro dynamical description for Plasma.
CLO 5	Able to apply the plasma theory for to solve the problems of flow of wave as well as fluids.

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme					
L	T	P	C	Internal			External		Total
				T	CE	P	Theory	P	
4	-	0	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	**Topi c**	**Weightag e**	**Teachin gHrs.**
1	**Solar Energy and Its Conversion**: Importance of Solar Energy: Nature of solar radiation, Sun as a fusionreactor, special distribution of extraterrestrial radiation, Estimation of extraterrestrial solar radiation, Radiation on horizontal and tilted surfaces. Available solar radiation, Measurement of beam, diffuse, global radiation. Conversion of Solar Energy in different form: Various ways toconvert solar energy into different forms, Pyranomater, Pyrhelimeter, Sunshine duration recorder Angstrom relation.	25%	15
2	**Geothermal Energy**: Introduction (Geothermal Resources), Geothermal Power Plants (DrySteam Units, Single-Flashing Units, Dual Flashing Units, Several Flashing Processes: A Useful Theoretical, Binary Units), Cooling Systems. Power from the Water: Hydroelectric Power (Global Hydroelectric Energy Production, Planned Hydroelectric Installations and Future Expansion, Environmental Impacts and Safety Concerns), Tidal Power(Systems for Tidal Power Utilization, Environmental Effects of Tidal Systems, Ocean Currents), Ocean Thermal Energy Conversion (OTEC) (Two Systems for OTEC, Environmental Effects of OTEC andOther Considerations), Types of Water Power Turbines, Concluding Remarks on Water Power.	25%	15
3	Fuel Cells: Design and principle of operation of a Fuel Cell (H2, O2cell), Classification of Fuel Cells, Types of Fuel Cells, Advantages and Disadvantages of Fuel Cells, Conversion efficiency of Fuel Cells, Work output and EMF of Fuel Cells, Applications of Fuel Cells-Hydrogen Energy, Hydrogen storage, Hydrogen transportation, Utilization of Hydrogen Gas, Safety and management, Hydrogen technology development.	25%	15

4	Wind Energy: Fundamentals and Applications Introduction, Merits and Limitations, Nature and Origin of Wind, Wind Energy Quantum, Variables in Wind Energy Conversion Systems, Wind Power Density, Power in a Wind Stream, Wind Turbine Efficiency, Power of a Wind Turbine, Forces on the Blade of a Propeller, Wind Velocities and Height from Ground, Mean Wind Velocity, Wind Velocity duration curve, Energy Pattern Factor, Wind Power duration Characteristics.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Classical Electromagnetism by H. C. Verma
2. Introduction to Classical Electrodynamics by Lim Y K
3. Introduction to Plasma Physics and Controlled Fusion by Francis F. Chen

Course Name: Lab-I
Course Code: 11204215
Prerequisite: basic laboratory instrumentations
Rationale: Experimental techniques in condensed matter physics
Course Learning Objective:

CLOBJ 1	Demonstrate Proficiency in Basic Laboratory Techniques
CLOBJ 2	Apply Theoretical Knowledge to Practical Situations
CLOBJ 3	Conduct Organic Synthesis and Reactions
CLOBJ 4	Use Spectroscopic Methods for Compound Identification.
CLOBJ 5	Practice Safe Laboratory Procedures.

Course Learning Outcomes:

CLO 1	Students will apply theoretical concepts from the Organic Chemistry lecture course to design and conduct experiments, demonstrating an understanding of the principles underlying reactions and synthesis.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Students will successfully carry out organic synthesis and reactions, producing desired products and demonstrating knowledge of reaction mechanisms and

	conditions.
CLO 4	Students will use spectroscopic methods, including infrared spectroscopy (IR) and nuclear magnetic resonance (NMR), to identify and characterize organic compounds accurately.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	4	2	-	-	40	-	60	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**-Continuous Evaluation, **ESE-** End Semester Examination

Text Book and Reference Book:

Techniques in Organic Chemistry" by Jerry R. Mohrig, David Alberg, Gretchen M. Adams, and Paul F. Schatz:.
"Organic Chemistry Laboratory Notebook" by Hayden-McNeil"Signals and Systems: Analysis Using Transform Methods & MATLAB" by M.J. Roberts.
"Organic Chemistry: Structure and Function" by K. Peter C. Vollhardt and Neil E. Schore:

Course Name: Lab-II
Course Code: 11204216
Prerequisite: Basic lab instrumentations
Rationale: Spectroscopy related experiments
Course Learning Objective:

CLOBJ 1	Demonstrate Proficiency in Basic Laboratory Techniques
CLOBJ 2	Apply Theoretical Knowledge to Practical Situations
CLOBJ 3	Conduct Organic Synthesis and Reactions
CLOBJ 4	Use Spectroscopic Methods for Compound Identification.
CLOBJ 5	Practice Safe Laboratory Procedures.

Course Learning Outcomes:

CLO 1	Theoretical concepts from the Organic Chemistry lecture course to design and

	conduct experiments, demonstrating an understanding of the principles underlying reactions and synthesis.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Carry out organic synthesis and reactions, producing desired products and demonstrating knowledge of reaction mechanisms and conditions.
CLO 4	Spectroscopic methods, including infrared spectroscopy (IR) and nuclear magnetic resonance (NMR), to identify and characterize organic compounds accurately.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	4	2	-	-	40	-	60	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

Text Book and Reference Book:

Techniques in Organic Chemistry" by Jerry R. Mohrig, David Alberg, Gretchen M. Adams, and Paul F. Schatz:.
"Organic Chemistry Laboratory Notebook" by Hayden-McNeil"Signals and Systems: Analysis Using Transform Methods & MATLAB" by M.J. Roberts.
"Organic Chemistry: Structure and Function" by K. Peter C. Vollhardt and Neil E. Schore:

Semester 4

Course Name: Physics of Solid state devices
Course Code: 11204253
Prerequisite: Properties of matters and types
Rationale: Understanding the properties of solid materials and semiconductor physics

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Able to understand and apply the knowledge of semiconductor and various measurement techniques in practice
CLO 2	Able to analyze the knowledge of excess carriers in semiconductor materials
CLO 3	Able to create the conceptual clarity of various electronic component/devices like Unipolar devices, BJT, Thyristor
CLO 4	Able to grasp the use of tunnel diode, IMPATT diode in the various microwave devices along with better clarity of concepts utilized in the field of photonic devices

Teaching & Examination Scheme:

Teaching Scheme				Examination Scheme		
L	T	P	C	Internal	External	Total

				T	CE	P	Theory	P	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **CE**- Continuous Evaluation

Course Content:

Sr.	Topic	Weightage	Teaching Hrs.
1	**Unit 1**: **Classification of solids** Semiconducting materials (elemental, compound, amorphous, organic and polymer), Charge carrier in semiconductor: Electrons and Holes, Effective Mass, Intrinsic and Extrinsic Semiconductors. Carrier concentrations: Variation of Fermi level with respect to temperature, electron and hole concentrations at equilibrium, temperature dependence of carrier concentration, conductivity and mobility, effect oftemperature and doping on mobility, Measurements: Four probe method for resistivity, Hall effect for carrier concentration and mobility, Hot probe method for type of conductivity.	25%	15
2	**Unit 2**: **Excess carrier in semiconductor:** Optical absorption, direct and indirect band gap semiconductor, Carrier lifetime and photoconductivity: direct recombination of electron and holes, indirect recombination. Steady state carrier generation: Quasi-Fermi levels. Diffusion of carriers: diffusion process, mechanics of diffusion, Fick's laws, experimental method, of diffusion coefficient, diffusivities of impurities in semiconductor and measurement techniques Drift of carriers: the continuity equation, steady state carrier injection: diffusion length, the Haynes-Schokely experiment.	25%	15
3	Unit 3: Bipolar devices: p-n junction diode, basics device technology, depletion region and depletion capacitance, current-voltage characteristic, junction breakdown, transient behaviour, heterojunction, application of diode, BJT: static characteristics, microwave transistor, power transistor, switching transistor, Thyristor: Basic characteristic, Shockley diode and three terminal thyristor, power thyristor, diac and triac, unijunction transistor and trigger thyristor. Unipolar devices- metal-semiconductor contacts: energy band relation, Schottky effect, current transport process, characterization of barrier height, ohmic contact, JFET, MOSFET: Basic device characteristic and its parameters and MOSFET structures, MIS diode and CCD: Ideal MIS diode, MOS diode, Charge-Coupled devices.	25%	15

4	Unit 4: Photonic devices- LED and semiconductor laser: LED-characteristics, efficiency, heterojunction LED, semiconductor laser-structure, operation and characteristics, photoconductors-photoconductor, photodiode, avalanche photodiode, phototransistor, optocoupler, solar cell. Microwave devices: Tunnel diode-basic characteristics and its application, IMPATT diode static and dynamic characteristic, power and efficiency, IMPATT diode applications.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Semiconductor Optoelectronic Devices (TextBook) P. Bhattacharya; Prentice Hall of India (1997)
2. Semiconductor Optoelectronics J. Singh; McGraw-Hill Inc, 1995
3. Semiconductor Devices: Physics and Technology S. M. Sze; Wiley, 2008
4. Photonics: Optical Electronics in Modern Communications A. Yariv and P. Yeh; Oxford University Press, New York (2007)
5. Fundamentals of Photonics B. E. A. Saleh and M. C. Teich; John Wiley & Sons

Course Name: Experimental and characterization techniques

Course Code: 11204254

Prerequisite: Basic experimental techniques

Rationale: Important to study the properties of materials, various experimental techniques and their roles

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.

CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Able to Understand the fundamental knowledge of vacuum pump and vacuum gauges.
CLO 2	Able to apply the knowledge of vacuum create the various pump for desired vacuum create inside the chamber.
CLO 3	Able to explain basic principle of nucleation and growth of nanomaterials.
CLO 4	Able to Understood the scientific approach to growth of nanomaterials by physical and chemical methods
CLO 5	Able to gain Knowledge about the working principle of various characterization techniques.
CLO 6	Able to Develop scientific motivation for research area to analyzed characteristic properties of the nanomaterials to identify the structural, compositional, optical and electrical properties.

Teaching & Examination Scheme:

Teaching Scheme				**Examination Scheme**					
				Internal			**External**		**Total**
L	**T**	**P**	**C**	**T**	**CE**	**P**	**Theory**	**P**	
4	**-**	**0**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **CE-** Continuous Evaluation

Course Content:

Sr.	**Topi c**	**Weightag e**	**Teachin gHrs.**

1	**Unit 1**: **Vacuum Pumps & Gauges** Experimental Techniques - General instrumental parameters for the surfaces, interfaces and bulk of solid materials. Vacuum Pumps: Rotary pump, Diffusion pump, Ion pump, Sorption pump, Turbomolecular pump. Gauges: Bourdon Gauge, Mcleod gauge, Piranigauge, paining gauge Thermocouple gauge, Hot and cold cathode ionization gauge. Vacuum Materials.	25%	15
2	**Unit 2**: **Nanomaterials Growth Techniques** Nucleation of nanomaterials, Chemical wet Processing, Solgel method,Spin coating, Dip coating, Physical vapor deposition - RF & DC sputtering, Thermal evaporation, E-beam evaporation, Pulsed Laser Deposition (PLD), Chemical vapour deposition (CVD); Reaction types, PECVD, LECVD, MOCVD, HTCVD, Molecular Beam Epitaxial Growth (MBE), Liquid Phase epitaxy (LPE), Vapour phase epitaxy (VPE) and Litheography Techniques.	25%	15
3	Unit 3: Material Characterization Techniques 1 Structural techniques: - Crystal structure identification and lattice parameter determination, Particle size determination using Bragg's law of X-ray diffraction. low energy electron diffraction (LEED). Compositional analysis techniques: Working principle and data analysis of X-ray photoelectron spectroscopy (XPS), Rutherford Back Scattering Spectrometry (RBS), Energy dispersive analysis (EDAX), X-ray fluorescence (XRF),), Auger electron spectroscopy (AES), Electron probe micro analyzer (EPMA), Elastic recoil detection analysis (ERDA).	25%	15
4	Unit 4: Material Characterization Techniques 2- Surface Techniques:- Electron microscopy- Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM), Field Emission Scanning elctron microscopy (FESEM), and Field Ion Microscopies (FIM), Application as Atom Probe- Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM). Spectroscopic techniques:- Raman Spectroscopy. Photoluminescence Spectroscopy, Electron spectroscopy for chemical analysis, FTIR, UV- VIS-NIR spectrophotometry & Ellipsometry Thermal Characterization. Differential scanning	25%	15

	calorimeter (DSC), Differential Thermal Analyzer (DTA). thermo-gravimetric analysis (TGA). Electrical characterization Techniques; Semiconductor device analyzer (SDA), Four probe method, Hall effect and Hall measurements, Time of Flight methods for charge carriers, Current-Voltage (I-V) and Capacitance-voltage (C-V) measurements.		
	Total	100%	60

Text Book and Reference Book:
1. Methods of Experimental Physics by by M. I. Pergament
2. Experimental Physics: Modern Methods by R.A. Dunlap

Course Name: Dissertation
Course Code: 11204255
Prerequisite: Depends of dissertation topic
Rationale: for understanding of research methods

Course Learning Objective:

CLOBJ 1	Develop proficiency in a range of analytical techniques such as spectroscopy, chromatography, and electrochemistry for accurate and precise measurement of chemical components.
CLOBJ 2	Acquire the ability to perform quantitative analysis by applying mathematical and statistical methods to experimental data, enabling accurate determination of concentrations and quantities.
CLOBJ 3	Gain hands-on experience and expertise in operating and troubleshooting modern analytical instruments, including spectroscopic and chromatographic tools, essential for practical applications in the field.
CLOBJ 4	Develop skills in interpreting complex data sets generated from analytical experiments.
CLOBJ 5	Learn to design and optimize analytical methods, considering factors such as sensitivity, selectivity, and precision, to address specific challenges in chemical analysis.
CLOBJ 6	Understand and adhere to essential laboratory safety protocols and good analytical practices to ensure a secure working environment and reliable experimental outcomes.

Course Learning Outcomes:

CLO 1	Proficiency in the theoretical aspects of various instrumental techniques employed in analytical chemistry, such as spectroscopy, chromatography, and electrochemical methods.
CLO 2	Theoretical competence in quantitative analysis, including the understanding of statistical methods and mathematical models applied to analyze experimental data and determine concentrations accurately.
CLO 3	Develop the ability to apply theoretical concepts to analyze molecular structures, elucidate chemical mechanisms, and interpret spectroscopic data to identify functional groups and molecular arrangements.
CLO 4	Understand the theoretical principles involved in designing and optimizing analytical methods, taking into consideration factors such as sensitivity, selectivity, and robustness for effective chemical analysis.
CLO 5	Develop strong theoretical foundations for interpreting complex analytical data, applying critical thinking skills to draw conclusions, make predictions, and evaluate the reliability and precision of experimental results.
CLO 6	Attain a conceptual understanding of analytical error sources, uncertainty propagation, and statistical treatment of uncertainties, enabling the critical assessment of measurement reliability and the implementation of error reduction strategies in analytical processes.

Teaching & Examination Scheme:

Teaching Scheme				**Examination Scheme**					
L	**T**	**P**	**C**	**Internal**			**External**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
-	**-**	**12**	**12**	**-**	**100**	**-**	**-**	**200**	**300**

L- Lectures; **T**- Tutorial; **P-** Practical; **C-** Credit; **CE**- Continuous Evaluation