Two-Year Postgraduate Programme

Master of Science

M.Sc. Chemistry

Faculty of Applied Sciences

Parul University

Vadodara, Gujarat, India

Faculty of Applied Sciences

Master of Science in Chemistry

1. **Vision of the Department:**
   Building foundation for excellence and spur development of the Institution as a premier Institution, by igniting and nurturing enthusiasm, interests and passion, in the study of chemistry, in professional courses, as a part of curriculum.

2. **Mission of the Department:**

M1	Awakening the young minds and discover their talents both in theory and in practical chemistry, through dedication to teaching, commitment to students and innovative instructional methods.
M2	Supporting the developmental activities of the College and make the Department vibrant.
M3	Organizing critical contributions in areas of emphasis such as faculty, modern labs, department library and demonstrate a high level of competence in the study of Chemistry.

3. **Program Educational Objectives**
   The statements below indicate the career and professional achievements that the curriculum enables graduates to attain.

PEO 1	To provide an environment for exploring the Research & Development attitude, to help the students in Research and Development field
PEO 2	To Analyse the problem and also think methodically, independently and draw a logical conclusion.
PEO 3	Demonstrate, solve and understand the major concepts in all disciplines of chemistry

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

PLO 1	**Disciplinary Knowledge**	Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PLO 2	**Critical Thinking and Problem Solving**	Identify the problem by observing the situation closely, take actions and analytical skills to design the solutions.
PLO 3	**Social Competence**	Exhibit thoughts and ideas effectively, build effective interactive and presenting skills to meet global competencies.
PLO 4	**Research-related Skills and Scientific Temper**	Infer scientific literature, build sense of enquiry and identify and consult relevant sources to find answers.
PLO 5	**Trans-**	Create new conceptual, theoretical and specific approaches to

	disciplinary Knowledge	address a common problem.
PLO 6	**Personal and Professional Competence**	Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PLO 7	**Effective Citizenship and Ethics**	Demonstrate empathetic social to professional ethics and responsibility.
PLO 8	**Environment and Sustainability**	Understand the impact of the scientific solutions in societal and environmental contexts.
PLO 9	**Self-directed and Life-long learning**	Acquire the ability to engage in independent and life-long learning in broadest context of socio-technological changes.

5. Program Specific Learning Outcomes

PSO 1	**Professional development**	To remember the scientific temperament in the students and outside the Scientific community
PSO 2	**Research skills**	To Create and Demonstrate, solve and understand the major concepts in all disciplines of chemistry.

6. Credit Framework

Semester wise Credit distribution of the programme	
Semester-1	26
Semester-2	26
Semester-3	26
Semester-4	26
Total Credits:	**104**

Category wise Credit distribution of the programme	
Category	**Credit**
Major Core	88
Elective	0
Dissertation	8
Comprehensive Viva	8
Total Credits:	**104**

7. Program Curriculum

Semester 1						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	11205101	Organic Chemistry-I	4	4	-	-
2	11205102	Inorganic Chemistry-I	4	4	-	-
3	11205103	Physical Chemistry-I	4	4	-	-
4	11205104/ 11205107	Analytical Chemistry-I/ Biophysical Chemistry	4	4	-	-
5	11205108	Lab-I: Organic Chemistry	4	-	8	-
6	11205109	Lab-II: Analytical Chemistry	4	-	8	-
7	11205110	Comprehensive viva	2	-	-	-
Total			**26**	**16**	**16**	**-**
Semester 2						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
8	11205151	Organic Chemistry-II	4	4	-	-
9	11205152	Inorganic Chemistry-II	4	4	-	-
10	11205153	Physical Chemistry-II	4	4	-	-
11	11205154/ 11205157	Analytical Chemistry-II/ Environmental pollutions	4	4	-	-
12	11205155	Lab-I (Inorganic Chemistry)	4	-	8	-
13	11205156	Lab-II (Physical Chemistry)	4	-	8	-
14	11205157	Comprehensive viva	2	-	-	-
Total			**26**	**16**	**16**	**-**
Semester 3						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
14	11205201	Pericyclic Reactions, Photochemistry and Free Radicals	4	4	-	-
15	11205202	Redox Reactions and Organometallics	4	4	-	-
16	11205203/ 11205207	Medicinal Chemistry/ Bioorganic Chemistry	4	4	-	-
17	11205204	Spectroscopy of Organic Compounds	4	4	-	-
18	11205208	Lab I: Organic Preparation	4	-	8	-
19	11205209	LabII: Organic Spotting and Organic Estimation	4	-	8	-
20	11205210	Comprehensive viva	2	-	-	-
Total			**26**	**16**	**16**	**-**
Semester 4						
Sr.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**

No.						
25	11205251	Drugs and Natural products	4	4	-	-
26	11205252	Stereochemistry and Disconnection Approach	4	4	-	-
27	11205253	Chemistry of Heterocyclic Compounds	4	4	-	-
28	11205280/ 11205281	Synthetic Dyes/ Industrial Chemical Processes	4	4	-	-
29	11205258	Dissertation	8	-	-	-
30	11205259	Comprehensive viva	2	-	-	-
Total			**26**	**16**	**-**	**-**

8. Detailed Syllabus

Semester: 1

- **Course Name:** Organic Chemistry-1
  Course Code: 11205101
  Prerequisite: Inclination to learn Organic Chemistry, Reaction mechanism and Energy relationship, Types of Organic Reactions, Molecular rearrangement reactions, Reactive intermediates
  Rationale: The course will provide strong foundation on organic chemistry. The course will demonstrate understanding of reaction mechanism and Energy relationship. Different type of organic reaction discuss in detail. The course also will provide basic knowledge of reactive intermediates and selected molecular rearrangement's reaction.

Course Learning Objective:

CLOBJ 1	Identify functional groups and their characteristic chemical properties.
CLOBJ 2	Comprehend the relationship between structure and reactivity in organic molecules.
CLOBJ 3	Utilize spectroscopic methods to analyze and identify organic compounds.
CLOBJ 4	Evaluate the mechanisms of organic reactions and propose alternate pathways.
CLOBJ 5	Judge the environmental and economic impact of various organic reactions and synthetic methods.
CLOBJ 6	Create innovative solutions to challenging organic synthesis problems.

Course Learning Outcomes:

CLO 1	Apply mechanisms of different reactions
CLO 2	Understand knowledge of organometallics reactions in industry
CLO 3	Scrutinize appropriate reagent for different types of reaction
CLO 4	Remember different name reactions & their mechanism
CLO 5	Apply knowledge of Organic chemistry concept practically in industry for reaction
CLO 6	Investigate issues related to sustainability, corporate social responsibility, and ethical decision-making in the industry.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
				Internal Evaluation			ESE		
L	T	P	C	MSE	CE	P	Theory	P	Total
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	**Reaction mechanism and Energy relationship** Introduction to organic reaction mechanism. Potential energy diagram, Energy of activation and Transition state. Methods of determining mechanism, Solvent effect, Substituent effect. Use of Isotopes to determine mechanism. Structural effects and reactivity: Linear free energy relationship (LFER) in determination of organic reaction mechanism, The Hammett equation, substituent constants, Theories of substituent effects, Interpretation of Values, Reaction constants, Yukawa-Tsuno equation. Deviations from Hammett equation, The Taft model, Solvent effects, Okamoto-Brown equation, Swain- Scott equation.	**25%**	**15**
2	**Types of Organic Reactions** Aliphatic nucleophilic substitution reactions: The SN1and SN2 reactions and their mechanisms and Stereochemistry, Leaving group effect and reaction medium. Aliphatic electrophilic substitution reactions: SE1 and SE2 reactions, Their mechanism and stereochemistry. Aliphatic addition reactions: Addition reactions of alkenes and alkynes. Aliphatic elimination reactions: E1 and E2 mechanism, Zaitsev's rule, Dehydration ;oH2O) of alcohols, Dehydrohalogenation (-HX) of haloalkanes, Hoffman elimination	**25%**	**15**
3	**Molecular rearrangement reactions** Mechanism to Nucleophilic, Electrophilic, and Free radical molecular rearrangements. Carbon-Carbon rearrangements: Pinacol- Pinacolone rearrangement, Wagner-Meerwein rearrangement, Tiffeneau-Demyanov rearrangement, Favorskii rearrangement, Wolff rearrangement, Benzil-Benzilic acid rearrangement, Neber rearrangement, Benzidine rearrangement, Carbon-Nitrogen rearrangements: Hoffmann rearrangement, Curtius rearrangement, Lossen Schmidt rearrangement and Beckmann rearrangements, Carbon-Oxygen rearrangements: Bayer-Villiger rearrangement, Dakin rearrangement and Wittig rearrangement	**25%**	**15**
4	**Reactive intermediates** Structure, Stability and Reactivity of intermediates, Carbocations: Generation and structure, Reactions involving carbocations, Carbanions: structure and reactivity, generation and reactions. Structure and reactivity and reactions of Free radicals, Carbenes and Nitrenes as intermediates, their structure and generation. Aryne: structure, generation mechanism and their reactions	**25%**	**15**
	Total	**100%**	**60**

Text Book & Reference Book:

1. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren
2. Advanced Organic Chemistry: Part A: Structure and Mechanisms by Francis A. Carey and Richard J. Sundberg
3. Advanced Organic Chemistry: Part B: Reactions and Synthesis by Francis A. Carey and Richard J. Sundberg
4. Organic Chemistry by Paula Yurkanis Bruice

- **Course Name:** Inorganic Chemistry-I
  Course Code: 11205102
  Prerequisite: Inclination to learn chemistry, basic knowledge of inorganic compound equations and difference equations.
  Rationale: Inorganic chemistry is a branch of chemistry that focuses on the study of inorganic compounds, which are compounds that do not contain carbon-hydrogen (C-H) bonds. It encompasses a wide range of chemical compounds, including minerals, metals, coordination compounds, and organometallic compounds.

Course Learning Objective:

CLOBJ 1	Recall and identify fundamental principles and concepts in inorganic chemistry, including periodic trends, chemical bonding theories, and coordination chemistry.
CLOBJ 2	Understand the relationships between atomic structure, chemical bonding, and the properties of inorganic compounds.
CLOBJ 3	Apply knowledge of inorganic chemistry principles to solve problems related to stoichiometry, equilibrium, and reaction kinetics in inorganic chemical reactions.
CLOBJ 4	Analyze experimental data and spectroscopic information to determine the structure, composition, and properties of inorganic compounds.
CLOBJ 5	Evaluate the scientific literature and research findings in inorganic chemistry, critically assessing experimental methodologies and data interpretation.
CLOBJ 6	Design experiments to synthesize and characterize new inorganic compounds, selecting appropriate synthetic routes and analytical techniques

Course Learning Outcomes:

CLO 1	Recall and describe the periodic trends in the periodic table, including atomic size, ionization energy, and electronegativity.
CLO 2	Explain the principles of chemical bonding in inorganic compounds, including ionic, covalent, and metallic bonding.
CLO 3	Apply knowledge of inorganic chemistry principles to predict the properties and reactivity of inorganic compounds under different conditions.
CLO 4	Evaluate the factors influencing the stability and reactivity of coordination complexes, such as ligand field theory and crystal field theory.
CLO 5	Assess the environmental and industrial implications of inorganic chemical

	processes and materials, considering factors such as toxicity, sustainability, and resource management.
CLO 6	Design experiments to synthesize and characterize inorganic compounds, selecting appropriate synthetic routes and analytical techniques.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	**Magnetochemistry** Magnetic susceptibility, Sources of paramagnetism, Diamagnetic susceptibility, Pascal constants and constitutive corrections, Langevin equation, Van Vleck's formula, Antiferromagnetism, Types of antiferromagnetism, Antiferromagenetic exchange pathways, Ferromagnetism and magnetic domains, Ferrimagnetism and canting, Spin-orbit coupling, Lande interval rule, Quenching of orbital magnetic moment by crystal field, Spin-orbit coupling on A and E terms, Spin-orbit coupling on T term.	25%	15
2	**Commutation Relations and Translational Motion of A Particle Commutation Relations** Commutative property, Momentum operator, Hamiltonian operator, Angular momentum operator, Angular momentum operators and their commutation relations, Shift operators and their commutation relations; The effect of shift operators on an Eigen value of the angular momentum. Translational Motion of A Particle Free particle, Particle in a box with infinite potential barrier, Quantization and quantum numbers, Symmetry of the wave functions, Use of the box model, Cubical box and degeneracy, Quantum mechanical tunnelling and problems.	25%	15
3	**Inorganic Polymers** Multicentric boranes and their topology, Carboranes and metallocarboranes. Inorganic Polymers and Ring compounds: Linear and cyclic Borazenes, Phosphazenes and thiazenes. Phosphonitrilic polymers. Synthesis, structure and bonding in organoboron and organosilicon. Applications of these compounds in organic synthesis.	25%	15
4	**Electron Spectroscopy of Transition Metal Complexes** Concept of crystal field theory(CFT), Ligand field theory (LFT) and Molecular orbital theory (MOT); Splitting of d-orbitals in various stereochemistry; Tetragonal distortion in octahedral complexes; Spectrochemical series; Nephelauxetic series; Electronic states and term symbols.	25%	15

	Total	**100%**	**60**

Text Book and Reference Book:

1. Descriptive Inorganic Chemistry by Geoff Rayner-Canham and Tina Overton
2. Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr
3. Inorganic Chemistry by J.D. Lee

- **Course Name:** Physical Chemistry-I
  Course Code: 11205103
  Prerequisite: Typically, students might be required to have completed introductory courses in general chemistry and physics. These courses provide fundamental concepts and principles that are essential for understanding physical chemistry. Students may also need a solid understanding of mathematical concepts, particularly calculus, as it is often used in physical chemistry.
  Rationale: Physical Chemistry provides a bridge between theoretical principles and experimental observations. It helps students understand the theoretical foundations behind chemical phenomena and how these principles can be applied to explain experimental results.

Course Learning Objective:

CLOBJ 1	Identify different types of chemical bonds and their characteristics.
CLOBJ 2	Explain the behavior of gases using the ideal gas law and kinetic theory.
CLOBJ 3	Use mathematical models to analyze chemical kinetics and reaction mechanisms.
CLOBJ 4	Analyze spectroscopic data to determine molecular structure and identify functional groups.
CLOBJ 5	Formulate strategies to solve challenging problems in physical chemistry.
CLOBJ 6	Critique scientific literature and research findings related to physical chemistry topics.

Course Learning Outcomes:

CLO 1	Recall fundamental laws and equations governing physical processes, such as the laws of thermodynamics and the Schrödinger equation.
CLO 2	Interpret phase diagrams and understand phase transitions.
CLO 3	Use mathematical techniques to analyze experimental data and solve problems in physical chemistry.
CLO 4	Break down complex chemical systems into simpler components and analyze their behavior using physical chemistry principles.
CLO 5	Assess the significance and impact of physical chemistry in various scientific disciplines and technological applications.
CLO 6	Develop innovative solutions to complex problems in physical chemistry by integrating knowledge from multiple domains.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	**The Gaseous state & The Kinetic Molecular Theory** The gaseous state, General characteristics of gases, The gas laws: Boyle's law, Charles' law, Gay Lussac's law, Avogadro's law, The Ideal-gas equation, Dalton's Law of Partial Pressures, Graham's law of Diffusion, Assumptions of the Kinetic Molecular Theory of Gases, Statement of Kinetic Gas Equation and the significance of the terms involved in it, Kinetic Gas Equation in terms of Kinetic Energy, Deduction of Gas Laws (Boyle's law, Charles' law, Avogadro's law & Graham's law of diffusion) as well as Ideal gas equation and Dalton's law of Partial Pressures from the Kinetic Gas Equation, Statement of the Maxwell Distribution Law of Molecular Velocities and its explanation, Different types of molecule velocities and their expressions, Collision Properties (Parameters), Transport phenomena viz. viscosity, thermal conductivity and diffusion in gases, Derivation of the different relationships between the mean free path and the coefficients of viscosity, thermal conductivity and the diffusion, Influence of temperature and pressure on coefficients of viscosity, thermal conductivity and diffusion, Degrees of Freedom (rotational and vibrational) and their calculations, Principle of Equipartition of Energy, Numericals	25%	15
2	**Electromotive Force (EMF) of Galvanic Cells** Introduction, Galvanic Cells, Reversible cells, Reversible electrodes, Single electrode potential, Electrical energy in a galvanic cell, Electrical energy and Free energy change of cell reaction, Relation between Electrical energy and Enthalpy of a cell reaction, Determination of ΔH^o, ΔG^o and ΔS^o of a cell reaction, EMF and Equilibrium constant of a cell reaction, Standard EMF and Equilibrium constant, The Nernst equation, Electrode-Concentration Cells, Electrolyte-Concentration Cells, Concentration cells with and without transference, Liquid Junction Potential, Hydrogen electrode, Calomel electrode, Silver-Silver electrode, Glass electrode, Quinhydrone electrode, Applications of EMF measurements, Potentiometric titrations, Acid-Base, Redox and Precipitation titrations, Numericals.	25%	15

3	**Polymer Chemistry** Introduction, Basic difference between simples molecules and polymers, Basic concepts, Nomenclature, Classification of polymers in terms of Origin, Chemical structure, Thermal response, Line structure, Ultimate form and applications, Tacticity, Crystallinity and Mode of synthesis, Synthesis of Polymers: Chain Growth and Step Growth polymerizations, Free radical polymerization and mechanism, Methods of initiating Free radical polymerization, Inhibitors and Retarders, Kinetics of Free radical chain polymerization, Factors (temperature, concentrations of initiator and monomer, pressure) determining radical chain polymerization and the properties of the resulting polymer, Equilibrium of Free radical polymerization, Difference between thermoplastics and thermosets, Difference between addition and condensation polymerization reactions, Cationic polymerization, Mechanism of Cationic polymerization: (i) Polymerization of styrene-mineral acid (ii) Polymerization of styrene in the presence of SnCl4 and (iii) Action of Strong Lewis acid in the presence of co-catalyst, Kinetics and thermodynamics of cationic polymerization, Anionic polymerization, Mechanism of anionic polymerization, Polymerization of styrene in liquid NH3 initiated by KNH2, Living polymers, Difference between cationic and anionic polymerization reactions, Step-growth polymerization, Examples of step-growth polymers: Polyesters, Polyamides, Polyurethanes, Polyethers, Ring opening polymerization, Co-ordination (Insertion) polymerization (Ziegler-Natta catalysts).	**25%**	**15**
4	**Polymer Chemistry-II** Radical Polymerization Processes: Bulk-, Solution-, Suspension-, and Emulsion Polymerization techniques and their comparison. Molecular weight of Polymers: Introduction, Number and weight-average concepts, Derivation of equations for number and weight average molecular weights, Equations for Sedimentation and viscosity average molecular weights, Molecular weight and Degree of polymerization, Polydispersity and Molecular weight distribution, Practical Significance of polymer molecular weight, List of methods of determining Mn , Mw and molecular weight distribution, Viscometry method: Introduction, Common names of viscosity, types of capillary viscometers, Experimental procedure for determining intrinsic viscosity and the use of Mark-Houwink- Sakurada equation to calculate Mv , Numericals.	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Physical Chemistry by Ira N. Levine
2. Quantum Chemistry and Spectroscopy by Thomas Engel and Philip Reid
3. Chemical Kinetics and Dynamics by Paul L. Houston

- **Course Name:** Analytical Chemistry-I

  Course Code: 11205104

  Prerequisite: Knowledge of Analytical Chemistry up to PG level

  Rationale: Prerequisites for analytical chemistry typically include a solid foundation in general and inorganic chemistry, knowledge of organic chemistry, understanding of physical chemistry principles, proficiency in mathematics, laboratory skills, familiarity with instrumental analysis methods, basic computer skills, and effective communication and critical thinking abilities.

Course Learning Objective:

CLOBJ 1	Interpret calibration curves, standard addition plots, and other graphical representations of analytical data.
CLOBJ 2	Describe the factors influencing the choice of analytical methods for different types of samples and analytes.
CLOBJ 3	Use statistical methods to analyze experimental data and evaluate the reliability of analytical measurements.
CLOBJ 4	Evaluate the performance characteristics of analytical methods, including sensitivity, accuracy, and precision.
CLOBJ 5	Critique analytical methods reported in scientific literature and assess their suitability for addressing research questions.
CLOBJ 6	Synthesize and communicate analytical results effectively through written reports, presentations, and graphical representations.

Course Learning Outcomes:

CLO 1	Remember the steps involved in sample preparation, data acquisition, and analysis in analytical chemistry.
CLO 2	Describe the factors affecting the accuracy, precision, and sensitivity of analytical measurements.
CLO 3	Use statistical methods to analyze data, evaluate measurement uncertainty, and make informed decisions in analytical experiments.
CLO 4	Evaluate the suitability of different analytical techniques for specific analytical tasks based on their strengths, limitations, and performance characteristics.
CLO 5	Critically evaluate analytical methods reported in scientific literature and assess their applicability and relevance to real-world problems
CLO 6	Synthesize knowledge from multiple sources to propose innovative solutions or improvements to existing analytical methods.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
				Internal Evaluation			ESE		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	**Basics of Electroanalytical techniques** Electrochemical methods:Definitions and terminology involved in electrochemistry. Specific ion selective electrodes:Glass electrode for H+ / Na+ ions, solid membrane electrode for fluoride, liquid membrane electrode for calcium. Enzyme±substrate electrode for NH3, and gas sensing electrodes for SO2/ NH3/CO2 / O2. Polarography: Principle, apparatus and electrodes systems, components of limiting current, residual current, migration current, diffusion current, catalytic current, convention current, adsorption current and kinetic current. Polarographic maxima, half-wave potential, derivation of relationship between half wave potential and diffusion coefficients, fractions governing diffusion current, Calibration curve method, standard addition method, effect of pH on polorography and applications Amperometry: Principle, apparatus and electrode system. Four different types of amperometric titrations, advantages and disadvantages of amperometry. Applications of amperometry. pH metry: Introduction, construction and working of different electrodes, Ion selective electrodes, Applications of pH measurements, acid-base titrations, polybasic acid-base titrations, determination of dissociation constant of weak acids and weak bases, determination of hydrolysis constant and degree of hydrolysis.	**25%**	**15**
2	**Chromatographic Methods** Principles of chromatography, classification of chromatographic techniques based on mechanism of retention, configuration, mobile and stationary phase. Efficiency of separation- plate theory (theoretical plate concept) and rate theory (Van Deemter equation). Principles and applications of Paper chromatography, Gas chromatography, thin layer chromatography, HPTLC, Ion exchange chromatography. Counter-current chromatography for isolation of natural products. Detectors involved in chromatographic techniques.	**25%**	**15**
3	**Thermal methods** Thermogravimetry analysis: Principle, construction and working of thermobalance, factors affecting TGA, Applications of TGA. Differential thermal analysis and differential scanning calorimetry: Principle, Instrumentation, factors affecting analysis and applications. Thermo mechanical analysis [TMA]. Instrumentation and application, thermometric titrations.	**25%**	**15**
4	**X-ray** Electron and neutron diffraction techniques X-ray Diffraction: Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, identification of units cells from systematic absences	**25%**	**15**

	in diffraction pattern. Electron diffraction: Theory, measurement techniques. Low energy electron diffraction. Neutron diffraction: Scattering of neutrons by solids. Measurement techniques, Elucidation of magnetically ordered unit cells.		
	Total	**100%**	**60**

Text Book and Reference Book:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis (7th ed.). Cengage Learning.
2. Harris, D. C. (2010). Quantitative Chemical Analysis (8th ed.). W. H. Freeman.
3. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of Analytical Chemistry (9th ed.). Cengage Learning.
4. Skoog, D. A., & West, D. M. (2014). Analytical Chemistry: An Introduction (7th ed.). Cengage Learning.
5. Harvey, D. T. (2017). Modern Analytical Chemistry (2nd ed.). McGraw-Hill Education.
6. Brereton, R. G. (2003). Chemometrics: A Practical Guide. Wiley.
7. Sharma, B. K. (2003). Instrumental Methods of Analysis (23rd ed.). Goel Publishing House.
8. Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2014). Introduction to Spectroscopy (5th ed.). Cengage Learning.
9. Rouessac, F., & Rouessac, A. (2007). Chemical Analysis: Modern Instrumentation Methods and Techniques (2nd ed.). Wiley.
10. Hutta, M. (2005). Environmental Analytical Chemistry. Springer.

- **Course Name:** Biophysical Chemistry

  Course Code: 11205107

  Prerequisite: Knowledge of Biophysical Chemistry up to PG level

  Rationale: Prerequisites for Biophysical chemistry typically include a solid foundation in general and inorganic chemistry, knowledge of organic chemistry, understanding of physical chemistry principles, proficiency in mathematics, laboratory skills, familiarity with instrumental analysis methods, basic computer skills, and effective communication and critical thinking abilities.

Course Learning Objective:

CLOBJ 1	Define the basic concepts and terminology used in biophysical chemistry, such as thermodynamics, kinetics, and molecular interactions.
CLOBJ 2	Interpret experimental data related to molecular interactions and structural changes in biological macromolecules.
CLOBJ 3	Utilize computational tools and software to simulate molecular interactions and dynamics.
CLOBJ 4	Evaluate the strengths and limitations of different biophysical techniques for studying biomolecular systems.
CLOBJ 5	Synthesize interdisciplinary knowledge from chemistry, physics, and biology to

	propose solutions to complex biophysical problems.
CLOBJ 6	Assess the validity and reliability of experimental methods and data in the context of biophysical research.

Course Learning Outcomes:

CLO 1	Define the fundamental concepts and theories in biophysical chemistry, including thermodynamics, kinetics, molecular structure, and spectroscopy
CLO 2	Explain the principles governing molecular interactions in biological systems, such as protein-ligand binding, enzyme catalysis, and nucleic acid structure.
CLO 3	Apply thermodynamic principles to predict the stability and folding pathways of proteins and nucleic acids.
CLO 4	Analyze experimental data to determine thermodynamic parameters, rate constants, and binding affinities of biomolecular interactions.
CLO 5	Design experiments to investigate biophysical properties of biological macromolecules and systems.
CLO 6	Evaluate the validity and reliability of experimental results and data interpretation in biophysical research.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Basic Thermodynamic and Biochemical Concepts** First Law of Thermodynamics: Systems, State Functions, Mathematical Statement, Work, Specific Heat, Internal Energy of an Ideal gas, Enthalpy, Dependence of Specific Heat on internal energy and enthalpy, Enthalpy changes of biochemical reactions, Global climate change. **Second Law of Thermodynamics:** Entropy, Entropy changes for reversible and irreversible processes, Statement, Interpretation of entropy. **Third Law of Thermodynamics:** Statement, Gibbs Free Energy, Relationship between the Gibbs Energy and the Equilibrium Constant, Calculations of the Gibbs Energy for the reaction catalyzed by the enzyme phosphoglucomutase, Gibbs energy for an ideal gas, Nitrogen fixation.	**25%**	**15**
2	**Kinetics and Enzymes** The rate of a chemical reaction, Parallel First order reaction, Sequential First order reaction, Second order reactions, The order of a reaction, Reactions that approach equilibrium,	**25%**	**15**

	Activation energy, Enzymes, Enzymes lower the activation energy, Enzyme mechanisms, Enzyme activity		
3	**Acids and Bases** Electrolytic dissociation and Electrolytes, Ionization, Basic of acidity and basicity, Bronsted Lowery Theory, Strength of acids and bases, Acid-base equilibria in water, Function and Structure of Biomolecules is pH dependent, Measurement of pH: Use of Indicators, Electrometric determination of pH, Buffers: Systems which resist changes in pH, Titrations: The interaction ofan acid with a base..	**25%**	**15**
4	**Oxidation/Reduction Reactions and Bioenergetics** Oxidation/Reduction reactions, Electrochemical Cells, The Nernst equation, Midpoint potentials for Biological molecules, Gibbs energy of formation and activity, Ionic Strength, Adenosine Triphosphate (ATP), Chemiosmotic hypothesis	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis (7th ed.). Cengage Learning.
2. Harris, D. C. (2010). Quantitative Chemical Analysis (8th ed.). W. H. Freeman.
3. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). Fundamentals of Analytical Chemistry (9th ed.). Cengage Learning.
4. Skoog, D. A., & West, D. M. (2014). Analytical Chemistry: An Introduction (7th ed.). Cengage Learning.
5. Harvey, D. T. (2017). Modern Analytical Chemistry (2nd ed.). McGraw-Hill Education.
6. Brereton, R. G. (2003). Chemometrics: A Practical Guide. Wiley.
7. Sharma, B. K. (2003). Instrumental Methods of Analysis (23rd ed.). Goel Publishing House.
8. Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2014). Introduction to Spectroscopy (5th ed.). Cengage Learning.
9. Rouessac, F., & Rouessac, A. (2007). Chemical Analysis: Modern Instrumentation Methods and Techniques (2nd ed.). Wiley.
10. Hutta, M. (2005). Environmental Analytical Chemistry. Springer.

- **Course Name:** Lab-I (Organic Chemistry)
  Course Code: 11205108
  Prerequisite: Students are usually expected to have a foundational understanding of general chemistry principles. This may include topics such as atomic structure, chemical bonding, stoichiometry, and basic laboratory techniques.
  Rationale: Prerequisites, such as completion of an introductory chemistry course, ensure that students have a foundational understanding of general chemical principles. This includes knowledge of atomic structure, chemical bonding, and basic concepts that are essential for comprehending organic chemistry.

Course Learning Objective:

CLOBJ 1	Recall and identify common laboratory equipment, safety procedures, and basic organic chemistry concepts relevant to experimental work.

CLOBJ 2	Interpret experimental protocols and procedures to understand the rationale behind experimental setups and reactions.
CLOBJ 3	Utilize laboratory equipment and instrumentation effectively to perform organic synthesis, purification, and analysis.
CLOBJ 4	Evaluate experimental results to assess the success of synthetic procedures, determine reaction yields, and propose mechanisms for observed reactions.
CLOBJ 5	Critically evaluate the quality and reliability of experimental data, identifying sources of error and potential improvements in experimental design.
CLOBJ 6	Design and execute original synthetic experiments, considering factors such as reaction conditions, reagent selection, and purification methods.

Course Learning Outcomes:

CLO 1	Recall the basic principles of organic chemistry, including functional group reactivity, reaction mechanisms, and spectroscopic methods commonly used in organic synthesis.
CLO 2	Understand the rationale behind experimental procedures and reactions performed in the organic chemistry laboratory.
CLO 3	Apply theoretical knowledge of organic chemistry to plan and execute multi-step synthesis routes for target molecules.
CLO 4	Analyze experimental data, including spectral data (NMR, IR, MS) and chromatographic profiles, to identify and characterize organic compounds.
CLO 5	Synthesize and purify organic molecules using appropriate synthetic strategies and purification techniques
CLO 6	Critically assess the safety hazards and environmental impact associated with organic synthesis methods and reagents.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**8**	**4**	**-**	**-**	**40**	**-**	**60**	**100**

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

Course Content:

Exp. No.	**Name of the Experiment**
1	Separation and identification of ternary organic mixtures: Tartaric acid, b-naphthol, acetanilide
2	Separation and identification of ternary organic mixtures: Benzoic acid, a-naphthol, acetanilide
3	Separation and identification of ternary organic mixtures: salicylic acid, p-nitroaniline, benzamide
4	Separation and identification of ternary organic mixtures: Sulphanilic acid, p-nitrophenol, nitrobenzene
5	Separation and identification of ternary organic mixtures: Benzoic acid, m-nitroaniline, benzaldehyde.

Exp. No.	Name of the Experiment
6	Separation and identification of ternary organic mixtures: B-naphthol, p-nitroaniline, acetanilide
7	Separation and identification of ternary organic mixtures: p-Aminobenzoic acid, b-naphthol, naphthalene
8	Organic preparation: Acetophenone to acetophenone oxime to acetanilide
9	Organic preparation: Benzoin to Benzil to Benzilic acid
10	Organic preparation: Aniline to Phenylazo-b-naphthol

Text Book and Reference Book:

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

- **Course Name:** Lab-II (Analytical Chemistry)
  Course Code: 11205109
  Prerequisite: Students are usually expected to have a foundational understanding of
  Rationale: Prerequisites for analytical chemistry typically include a solid foundation in general and inorganic chemistry, knowledge of organic chemistry, understanding of physical chemistry principles, proficiency in mathematics, laboratory skills, familiarity with instrumental analysis methods, basic computer skills, and effective communication and critical thinking abilities.

Course Learning Objective:

CLOBJ 1	Interpret calibration curves, standard addition plots, and other graphical representations of analytical data.
CLOBJ 2	Describe the factors influencing the choice of analytical methods for different types of samples and analytes.
CLOBJ 3	Use statistical methods to analyze experimental data and evaluate the reliability of analytical measurements.
CLOBJ 4	Evaluate the performance characteristics of analytical methods, including sensitivity, accuracy, and precision.
CLOBJ 5	Critique analytical methods reported in scientific literature and assess their suitability for addressing research questions.
CLOBJ 6	Synthesize and communicate analytical results effectively through written reports, presentations, and graphical representations.

Course Learning Outcomes:

CLO 1	Remember the steps involved in sample preparation, data acquisition, and analysis in analytical chemistry.
CLO 2	Describe the factors affecting the accuracy, precision, and sensitivity of analytical measurements.
CLO 3	Use statistical methods to analyze data, evaluate measurement uncertainty, and make informed decisions in analytical experiments.
CLO 4	Evaluate the suitability of different analytical techniques for specific analytical tasks based on their strengths, limitations, and performance characteristics.
CLO 5	Critically evaluate analytical methods reported in scientific literature and assess their applicability and relevance to real-world problems
CLO 6	Synthesize knowledge from multiple sources to propose innovative solutions or improvements to existing analytical methods.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	8	4	-	-	40	-	60	100

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

Course Content:

Exp. No.	Name of the Experiment
1	Visible Spectrometry : Determination of λmax and concentration of KMnO4 solution
2	Determination of Cu (II) by Spectrophotometric titration.
3	Determination of purity of vanillin by conductometry
4	Assay of aspirin tablet by potentiometry and titrimetry.
5	Column chromatographic separation and estimation of KMnO4 and K2Cr2O7
6	Determination of purity of ascorbic acid.
7	Determination of COD of effluent sample
8	Determination of saponification value of oil.
9	Determination of chlorine content in bleaching powder by iodometry.
10	Paper chromatographic separation of metal ions (Fe3+, Cu2+ and Ni2+)
11	Determination of purity of given sample of potassium ferricyanide.
12	Estimation of hydrogen peroxide in solution using titrimetry.
13	Determination of uranium-oxine complex using solvent extraction method.
14	Determination of amount of surfactant using solvent extraction method.
15	Separation and identification of flavonols from tea by paper chromatography.
16	Separation and identification of anthocyanins by paper chromatography.

Text Book and Reference Book:

1. Techniques in Organic Chemistry by Jerry R. Mohrig, David Alberg, Gretchen M. Adams, and Paul F. Schatz:.

2. Organic Chemistry Laboratory Notebook" by Hayden-McNeilSignals and Systems: Analysis Using Transform Methods & MATLAB" by M.J. Roberts.
3. Organic Chemistry: Structure and Function" by K. Peter C. Vollhardt and Neil E. Schore

Semester: 2

- **Course Name:** Organic Chemistry-I

  Course Code: 11205151

  Prerequisite: Inclination to learn Organic Chemistry, methods in organic synthesis and organic reagents. Demonstration of types of Organic Reactions, Molecular rearrangement Heterocyclic compounds and Supramolecular chemistry.

  Rationale: The course will provide strong foundation on organic chemistry. The course will demonstrate understanding of methods of organic synthesis.

Course Learning Objective:

CLOBJ 1	Recall and describe fundamental principles and concepts of organic chemistry.
CLOBJ 2	Apply theoretical knowledge to solve problems related to organic compounds and reactions.
CLOBJ 3	Analyze the structure, properties, and reactivity of organic molecules.
CLOBJ 4	Demonstrate proficiency in laboratory techniques for synthesis, purification, and characterization of organic compounds
CLOBJ 5	Formulate hypotheses and design experiments to investigate chemical phenomena in the context of organic chemistry.
CLOBJ 6	Communicate experimental findings and theoretical concepts effectively through oral and written presentations.

Course Learning Outcomes:

CLO 1	Memorize key reaction mechanisms and principles of organic synthesis.
CLO 2	Describe the stereochemistry and conformational analysis of organic molecules.
CLO 3	Solve problems involving retrosynthetic analysis and multi-step synthesis
CLO 4	Interpret experimental data to propose mechanistic explanations for observed outcomes.
CLO 5	Assess the efficiency and sustainability of synthetic routes for organic compounds.
CLO 6	Develop synthetic strategies for the synthesis of bioactive compounds or materials with specific properties.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
				Internal Evaluation			ESE		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours

1	**Methods in Organic Synthesis** A review of various synthetic methods in organic chemistry: Formation of C-C, single and multiple bonds, Formation of various ring (namely 3, 4, 5, 6, 7 and 8- membered ring) compounds; Disconnection approach, Chemoselective synthesis, Introduction to various aspects of asymmetric synthesis, Resolution, Chiral auxiliaries, Chiral ligands, Chiral catalysts, and Organo catalysts with specific examples, Biosynthesis and Biomimetic synthesis. Protecting groups: Protection of hydroxyl, carboxyl, carbonyl and amino groups. Protection of carbon-carbon multiple bonds.	**25%**	**15**
2	**Organic Reagents and Reactions** General introduction; Modern oxidizing and reducing reagents with applications; Organotransition metal reagents: Organosilicon, Organotin, Organoborane, Organocopper, Organopalladium and Functionalized Grignard reagents; Oragnocatalysts; Metal carbonyl reagents; Lewis Acids, Tebbe reagent, Corey-Nicolaou reagent, Peterson's synthesis, Baker's yeast, Lipase, Mosher's reagent in organic synthesis.	**25%**	**15**
3	**Common name reactions and its applications** Reactions, mechanism and applications of the following name reactions: Baker Venkataraman reaction, Reformatsky reaction, Robinson annulation, Cannizzaro reaction, Dieckmann reaction, Perkin Reaction, Stobbe condensation, Bischler Napieralski reaction, Wittig rearrangement, Benzoin Condensation, Blanc Reaction, Bouveault-Blanc Reduction, Fukuyama Coupling, Friedel-Crafts Alkylation, Friedel-Crafts Acylation, Sharpless Asymmetric Epoxidation.	**25%**	**15**
4	**Heterocyclic compounds and Supramolecular chemistry** Introduction to Heterocyclic compounds. Structure and nomenclature of some common 3-, 4-, 5-, 6-, 7-membered heterocyclic compounds. Synthesis and applications of Pyrrole, Furan and Thiophene, Pyridine, Pyrimidines, Oxazines and Azapines. Fused ring heterocyclic compounds: Synthesis and applications of Quinolines, Isoquinoline, Indoles and Purines. Nucleic acids: structure and functions of DNA and RNA. Metal Porphyrins: Haemoglobin and Myoglobin Introduction to Supramolecular chemistry: Cation binding host molecules and its uses, Anion binding host compounds, Neutral molecule trapping host compounds	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren
2. Advanced Organic Chemistry: Part A: Structure and Mechanisms by Francis A. Carey and Richard J. Sundberg
3. Advanced Organic Chemistry: Part B: Reactions and Synthesis by Francis A. Carey and Richard J. Sundberg
4. Organic Chemistry by Paula Yurkanis Bruice

- **Course Name:** Inorganic Chemistry-II
  Course Code: 11205152
  Prerequisite: Inclination to learn chemistry, basic knowledge of inorganic compound equations and difference equations.
  Rationale: Inorganic chemistry explores the composition, structure, and properties of compounds that do not involve carbon-hydrogen bonds. This includes metals, minerals, salts, and various other substances.

Course Learning Objective:

CLOBJ 1	Analyze the fundamental principles and concepts of inorganic chemistry.
CLOBJ 2	Apply theoretical knowledge to solve problems related to inorganic compounds and reactions.
CLOBJ 3	Evaluate the properties and behaviors of various classes of inorganic compounds.
CLOBJ 4	Demonstrate proficiency in laboratory techniques for synthesizing and characterizing inorganic compounds.
CLOBJ 5	Formulate hypotheses and design experiments to investigate chemical phenomena in the context of inorganic chemistry.
CLOBJ 6	Communicate experimental findings and theoretical concepts effectively through oral and written presentations.

Course Learning Outcomes:

CLO 1	Memorize common nomenclature rules for inorganic compounds.
CLO 2	Describe the structure and bonding in coordination compounds
CLO 3	Apply knowledge of acid-base chemistry to predict the behavior of inorganic acids and bases.
CLO 4	Break down complex reactions into elementary steps and mechanisms
CLO 5	Assess the toxicity and hazards associated with inorganic compounds
CLO 6	Develop experimental protocols for the characterization of unknown inorganic substances.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
				Internal Evaluation			ESE		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours

1	**Electron spectroscopy of transition metal complexes:** Correlation diagrams-Splitting of the weak and strong field in their respective group theoretical terms, Correlation diagram for d2 configuration in octahedral symmetry; Orgel diagram-Orgel diagram for the d1 octahedral case. Orgel diagram for the d2 octahedral case; Tanabe Sugano Diagrams, Selection rule; Determination of Dq and electronic parameters, Interpretation of spectra.	**25%**	**15**
2.	**Bio-Inorganic Chemistry** Metalloporphyrins (enzymes) definition, hemoglobin and myoglobin, cytochrome, vitamin B12 (cyanocobalamin), zincmetallo enzymes, nitrogen fixation, essential and trace elements in biological systems, biochemistry of non metals K, Na pump (action of both ions), toxic metals and their toxicity Medicinal use of metal complexes as antibacterial, anticancer, use of cis-platin as antitumor drug, antibiotics & related compounds. Metal used for dignosis and chemotherapy with particular reference to anti cancer drugs. metal complexes as radio diagnostic agents, magnetic resonance imaging	**25%**	**15**
3	**Symmetry and Group theory** Symmetry elements and operations, Representation of symmetry operations as matrices, Definition of groups, Sets of symmetry operations of molecules satisfying the conditions of a group, Generators, Axial, non-axial and special point groups, Applications..	**25%**	**15**
4	**Organometallic Compounds** Introduction and nature of bonding in organo metallic compounds of transition metals: σ-bonded organo metallic compounds: Introduction, Classification and synthesis of σ-bonded organotransition metal compounds, General characteristics, chemical reactions, bonding and structure. π–bonded organometallic compounds: Introduction and Classification of π–bonded organometallic compounds (a) η2–alkene complexes: Preparative methods, Physical properties, Chemical properties, Bonding of structure η3allyl (or enyl) complexes preparation, physical of chemical properties.	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Descriptive Inorganic Chemistry" by Geoff Rayner-Canham and Tina Overton
2. Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr
   Inorganic Chemistry by J.D. Lee

- **Course Name:** Physical Chemistry-2
  Course Code: 11205153
  Prerequisite: Physical chemistry is a branch of chemistry that combines principles of physics and chemistry to understand how matter behaves on a molecular and atomic level. To study physical chemistry effectively, it is beneficial to have a strong foundation in certain prerequisite subjects. Here are some key prerequisites for physical chemistry:

Rationale: Physical chemistry serves as a bridge between physics and chemistry, combining principles from both disciplines. A background in general chemistry and physics is crucial to understanding the molecular and atomic aspects of physical chemistry.

Course Learning Objective:

CLOBJ 1	Understand the fundamental principles and laws governing chemical systems, including thermodynamics, kinetics, and quantum mechanics.
CLOBJ 2	Apply mathematical and computational tools to analyze and solve problems in physical chemistry, including mathematical derivations and numerical simulations.
CLOBJ 3	Develop a conceptual understanding of the molecular structure and behavior of gases, liquids, solids, and solutions.
CLOBJ 4	Explore the relationships between molecular structure, intermolecular forces, and macroscopic properties of matter.
CLOBJ 5	Gain proficiency in using experimental techniques and instrumentation relevant to physical chemistry research, such as spectroscopy, calorimetry, and electrochemistry.
CLOBJ 6	Apply statistical mechanics to describe the behavior of ensembles of molecules and predict thermodynamic properties

Course Learning Outcomes:

CLO 1	Demonstrate proficiency in applying the laws of thermodynamics to analyze and predict the behavior of chemical systems, including phase transitions, equilibrium, and chemical reactions.
CLO 2	Utilize quantum mechanics to describe the electronic structure of atoms and molecules, and interpret spectroscopic data to elucidate molecular properties.
CLO 3	Apply mathematical techniques, such as differential equations and linear algebra, to solve problems in physical chemistry and analyze experimental data.
CLO 4	Describe the behavior of ideal and real gases, and apply the concepts of partial pressures, fugacity, and activity coefficients to non-ideal systems
CLO 5	Analyze the relationship between molecular structure, intermolecular forces, and properties such as boiling point, viscosity, and solubility.
CLO 6	Perform and interpret experiments in physical chemistry using techniques such as UV-Vis spectroscopy, calorimetry, and potentiometry.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	**Statistical Thermodynamics** Introduction, Aspects of statistics, Definition of microscopic states, Statistical weight, Macroscopic states, Most probable distribution system, Assembly, Assembly of localized and non-localized systems, Ensemble, Micro-canonical ensemble, Macro canonical ensemble and grand canonical ensemble, Boltzmann and Planck equation, Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein Statistics, Partition function and its significance, Translational, Rotational, Vibrational and Electronic partition functions and their evaluation, Thermodynamic properties in terms of partition functions, Internal energy, Molar heat capacity, Entropy and free energy functions, Translational, rotation and vibrational entropies of ideal mono atomic gases, Sackur-Tetrode equation, Statistical expression for equilibrium constant for metathetic reactions, Numericals	**25%**	**15**
2.	**The Properties of solutions** Ideal solutions & its properties, The Duhem-Margules equation, Application of Raoult's law to both constituents of an idealsolution, Vapour Pressure curves for an Ideal solution, Composition of liquid & vapour in equilibrium, Non-ideal solutions & its vapour pressure curves, Dilute solutions, Henry's Law. **Solutions of electrolytes**: Mean ionic activity, Mean ionic activity coefficient & mean ionic molality of the electrolyte, Listing of the methods determining mean ionic activities, Ionic strength principle, Numericals.	**25%**	**15**
3	**Fugacity and Activity & Partial Molar Properties** Fugacity and Activity: Introduction, Definition of fugacity, Methods of determining Fugacity of a gas: Graphical method, Equation of State method, Approximate and Generalized methods, Variation of Fugacity with temperature and pressure, Fugacity of solids and liquids, Mixture of Ideal and Real gases, Determination of Fugacity in gas mixtures, The Lewis-Randall rule, Variation of fugacity of a gas in a mixture with temperature and pressure, Numericals. Partial Molar Properties: Introduction, Fundamental equations, Thermodynamic significance, Apparent molar property, Relation between Apparent molar property & Partial molar property in the case of an infinitely dilute solution, Methods of determining Partial molar properties: Direct method, Intercept method & Use of apparent molar property method, Partial molar volumes from density measurements, Determination of apparent molar volume of solute, Numericals.	**25%**	**15**
4	**Free Energy and Chemical Reactions** Chemical Equilibrium, The equilibrium constant, Equilibrium in homogeneous gaseous systems, The ammonia equilibrium, Homogeneous reactions in liquid solutions as well as in dilute	**25%**	**15**

	solutions, The reaction isotherm, Standard free energy of reaction, The direction of chemical change, Variation of equilibrium constant with pressure and temperature, Integration of the Van't Hoff equation, Variation of standard free energy with temperature, Determination of standard free energies, Numericals.		
	Total	**100%**	**60**

Text Book and Reference Book:

1. Physical Chemistry for JEE Main & Advanced by Vipul Mehta
2. Concise Inorganic Chemistry by J D Lee
3. Physical Chemistry by P W Atkins
4. Advanced Problems in Organic Chemistry by M S Rao

- **Course Name:** Analytical Chemistry-I
  Course Code: 11205154
  Prerequisite: The curriculum offers a solid grounding in Analytical Chemistry, Statistics, and effective Laboratory Practices. It covers the significance, functionality, and data analysis associated with Mass Spectrometry and Molecular Spectroscopy. Additionally, it provides a concise overview of Environmental Chemistry.
  Rationale: The program aims to establish a robust groundwork in Analytical Chemistry, Statistics, and proficient Laboratory Practices. It delves into the essential understanding of Mass Spectrometry and Molecular Spectroscopy, covering their applications, operational mechanisms, and data interpretation. Additionally, it offers an overview of Environmental Chemistry, highlighting its importance within the broader scope of scientific study.

Course Learning Objective:

CLOBJ 1	Define key terms and concepts in analytical chemistry.
CLOBJ 2	Explain the theoretical basis of analytical methods.
CLOBJ 3	Apply analytical methods to solve problems in real-world scenarios.
CLOBJ 4	Analyze experimental data to draw conclusions about sample composition.
CLOBJ 5	Design experiments to address specific analytical challenges.
CLOBJ 6	Assess the quality and reliability of analytical data

Course Learning Outcomes:

CLO 1	Recall the principles of common analytical techniques.
CLO 2	Summarize the steps involved in sample preparation and analysis.
CLO 3	Utilize appropriate instrumentation for specific analytical tasks.
CLO 4	Compare and contrast different analytical methods for a given problem.
CLO 5	Develop new analytical methods or protocols.
CLO 6	Critically assess the suitability of selected analytical methods for particular applications.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No	Content	Weigh tage	Teac hing Hour
1	**Statistics and Good Laboratory Practices** Statistics for chemists: Mean, Median, Mode, Standard deviation, Sources of variation in data, confidence limits of mean, significance test, Comparison of means, paired test, F test for variance, outliers.Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty. Errors in instrumental analysis: Types of errors, Significant errors, Precision and accuracy, Confidence limits, Calibration curves, line of regression, errors in slope and intercept. **Good Laboratory Practices** GLP Principles, Documentation of laboratory work, Preparation of Standard Operating Procedures (SOPs), Validation of methods, Reporting and documentation of results, Quality Control and Quality Assurance, Types of Quality Standards for laboratories, Total Quality Management, Audits.	25%	15
2	**Mass spectrometry** Different types of ion sources, mass analyzers and detectors, resolution and resolving power, interpretation of mass spectra, hyphenated systems like LC-MS, GC-MS, MS-MS	25%	15
3	**Molecular Spectroscopy** Overview of molecular spectroscopy: Different aspects of molecular spectroscopy, theBorn-oppenheimer approximation, transition probability, oscillator strength, the integratedabsorption coefficient. Microwave spectroscopy: Classification of the rotors, intensity of the rotational lines,population of energy levels, non-rigid rotation, anharmonicity and centrifugal distortion,effect of isotopic substitution. Rotation spectra of the linear, spherical top andasymmetric top polyatomic molecules, microwave technique **Infrared and Raman spectroscopy** Types of vibration bands- overtones, combination bands, Fermi resonance phenomenon and the finger print region, FTIR spectroscopy and application. Rayleigh and Raman scattering, polarizabilities, rotational and vibrational Raman spectra, selection rules, polarization of the light and Raman effect, resonance Raman and coherent anti- Raman spectroscopy.	25%	15
4	**Environmental Chemistry** Chemical Speciation and toxicity of particulate, gaseous and soluble pollutants, remedial measures and methods to control industrial air pollution. Water Chemistry: Chemistry of water,	25%	15

	concept of DO, BOD, COD, sedimentation, coagulation and filtration Soil Chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils. Toxic Chemicals in the environment: Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon Monoxide, PAN Pesticides and Insecticides.		
	Total	**100%**	**60**

Text Book and Reference Book:

1. Quantitative Chemical Analysis by Daniel C. Harris
2. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch
3. Instrumental Methods of Analysis by Hobart H. Willard, Lynne L. Merritt, Jr., and John A. Dean
4. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch
5. Modern Analytical Chemistry by David Harvey

- **Course Name:** Lab-I (Inorganic Chemistry)
  Course Code: 11205155
  Prerequisite: Students are usually expected to have a foundational understanding of general chemistry principles. This may include topics such as atomic structure, chemical bonding, stoichiometry, and basic laboratory techniques.
  Rationale: Prerequisites, such as completion of an introductory chemistry course, ensure that students have a foundational understanding of general chemical principles. This includes knowledge of atomic structure, chemical bonding, and basic concepts that are essential for comprehending organic chemistry.

Course Learning Objective:

CLOBJ 1	Recall safety protocols and procedures specific to handling inorganic chemicals
CLOBJ 2	Understand the principles underlying various experimental procedures in inorganic chemistry.
CLOBJ 3	Apply appropriate laboratory techniques for the synthesis and characterization of inorganic compounds.
CLOBJ 4	Analyze experimental data and observations to draw conclusions about the properties and behaviors of inorganic compounds.
CLOBJ 5	Design and execute experiments to synthesize specific inorganic compounds.
CLOBJ 6	Evaluate the quality and reliability of experimental data obtained in the laboratory.

Course Learning Outcomes:

CLO 1	Remember the properties and characteristics of common inorganic compounds.
CLO 2	Interpret experimental protocols and follow them accurately.
CLO 3	Apply laboratory techniques effectively to synthesize and characterize inorganic compounds.

CLO 4	Identify and troubleshoot errors in experimental procedures.
CLO 5	Devise new experimental procedures or modifications to existing ones as needed.
CLO 6	Assess the effectiveness of experimental procedures and techniques used.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	8	4	-	-	40	-	60	100

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

Course Content:

Exp. No.	Name of the Experiment
1	Qualitative analysis of mixtures: Cations Ag, Pb, Hg, Cu, Cd, Sn, Bi, As, Sb, Fe, Al, Cr, Co, Ni, Mn, Zn, Ca, Sr, Ba, Mg, Na and K. NH4+
2	Qualitative analysis of mixtures: Rare earth cations W, Tl, Mo, Ce, Ti, Th, Zr, U, V, Be and Li.
3	Qualitative analysis of mixtures: Anions F-, Cl-, Br-, I-, NO2- , NO3-, S2-, SO32-, SO42-, S2O32-, CrO42-, Cr2O72-, CO32-, PO43-, AsO43-, AsO33-,BO33-,CH3COO-,C2O42-
4	Synthesis of complexes of transition metal ions with ammonia.
5	Synthesis of complexes of transition metals with thiocyanate.
6	Synthesis of complexes of transition metals with ethylenediamine.
7	Synthesis of complexes of transition metals with tertiary amines
8	Synthesis of complexes of transition metals with acetylacetone.

Text Book and Reference Book:

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

- **Course Name**: Lab-2 (Physical Chemistry)
  Course Code: 11205156
  Prerequisite: Prerequisite for Physical Chemistry Lab: Successful completion of foundational courses in analytical chemistry theory and basic laboratory techniques.
  Rationale: The analytical chemistry lab serves to reinforce theoretical concepts, providing hands-on experience crucial for developing practical skills in experimental design, data acquisition, and instrument operation.

Course Learning Objective:

CLOBJ 1	Recall safety procedures and protocols specific to physical chemistry laboratory

	work.
CLOBJ 2	Understand the experimental procedures and protocols outlined in laboratory manuals.
CLOBJ 3	Apply laboratory techniques accurately for conducting physical chemistry experiments.
CLOBJ 4	Analyze experimental data to draw conclusions about physical phenomena and chemical behavior.
CLOBJ 5	Design experiments to investigate specific physical chemistry phenomena or properties.
CLOBJ 6	Evaluate the quality and reliability of experimental data obtained in the laboratory.

Course Learning Outcomes:

CLO 1	Remember the principles and theories underlying physical chemistry experiments.
CLO 2	Interpret experimental data collected during physical chemistry experiments
CLO 3	Utilize instrumentation effectively to obtain experimental data.
CLO 4	Evaluate the reliability and accuracy of experimental results, considering sources of error and uncertainty.
CLO 5	Judge the significance and implications of experimental findings within the broader context of physical chemistry research.
CLO 6	Design original experiments to investigate specific physical chemistry phenomena or questions.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**8**	**4**	**-**	**-**	**40**	**-**	**60**	**100**

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

Course Content:

Exp. No.	**Name of the Experiment**
1	Conductometry
2	Mixture of Strong acid and Weak acid (Titration)
3	Hydrolysis constant of a given salt
4	CMC of surfactant by conductometric method
5	Dissociation constant by dilution method
6	Mixture of weak acid and strong acid
7	Precipitation titration.
8	Redox potential
9	pK1 and pK2 by titration method
10	Acid Mixture titration

11	pK1 and pK2 of a diprotic acid.
12	pH - indicator - Dissociation constant
13	Relative strength of the acids by Polarimetry
14	Molecular weight of polymer by Viscometry
15	Energy of activation for hydrolysis of methyl acetate.
16	CMC of surfactant by Surface Tension measurement.

Text Book and Reference Book:

1. Analytical Chemistry, Methods and Applications,Jessica Carol,Willford Press
2. Experiments In Analytical Chemistry, A.V.R. Reddy K.K. Swain K. Venkatesh, Perfect Prints
3. Text book of Analytical Chemistry, Mumtaz Alam, Elsevier

- **Course Name:** Environmental Pollution-I
  Course Code: 11205157
  Prerequisite: The curriculum offers a solid grounding in Analytical Chemistry, Statistics, and effective Laboratory Practices. It covers the significance, functionality, and data analysis associated with Mass Spectrometry and Molecular Spectroscopy. Additionally, it provides a concise overview of Environmental Chemistry.
  Rationale: The program aims to establish a robust groundwork in Analytical Chemistry, Statistics, and proficient Laboratory Practices. It delves into the essential understanding of Mass Spectrometry and Molecular Spectroscopy, covering their applications, operational mechanisms, and data interpretation. Additionally, it offers an overview of Environmental Chemistry, highlighting its importance within the broader scope of scientific study.

Course Learning Objective:

CLOBJ 1	Analyze the various sources and types of environmental pollution.
CLOBJ 2	Evaluate the impact of environmental pollution on ecosystems, human health, and biodiversity.
CLOBJ 3	Apply scientific principles and methods to assess and monitor environmental pollution.
CLOBJ 4	Design and propose effective strategies for the prevention and mitigation of environmental pollution.
CLOBJ 5	Collaborate effectively with peers to develop solutions for real-world environmental pollution problems.
CLOBJ 6	Communicate complex environmental issues and solutions clearly and persuasively to diverse audiences.

Course Learning Outcomes:

CLO 1	Recall key pollutants and their sources
CLO 2	Interpret scientific data related to environmental pollution.
CLO 3	Apply pollution control technologies and strategies to mitigate pollution.

CLO 4	Analyze case studies to understand the causes and effects of pollution incidents.
CLO 5	Assess the economic and social costs of pollution.
CLO 6	Design comprehensive pollution prevention plans for industrial facilities.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No	Content	Weightage	Teaching Hours
1	**Statistics and Good Laboratory Practices** Statistics for chemists: Mean, Median, Mode, Standard deviation, Sources of variation in data, confidence limits of mean, significance test, Comparison of means, paired test, F test for variance, outliers.Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty. Errors in instrumental analysis: Types of errors, Significant errors, Precision and accuracy, Confidence limits, Calibration curves, line of regression, errors in slope and intercept. **Good Laboratory Practices:** GLP Principles, Documentation of laboratory work, Preparation of Standard Operating Procedures (SOPs), Validation of methods, Reporting and documentation of results, Quality Control and Quality Assurance, Types of Quality Standards for laboratories, Total Quality Management, Audits.	25%	15
2	**Mass spectrometry** Different types of ion sources, mass analyzers and detectors, resolution and resolving power, interpretation of mass spectra, hyphenated systems like LC-MS, GC-MS, MS-MS	25%	15
3	**Molecular Spectroscopy** Overview of molecular spectroscopy: Different aspects of molecular spectroscopy, theBorn-oppenheimer approximation, transition probability, oscillator strength, the integratedabsorption coefficient. Microwave spectroscopy: Classification of the rotors, intensity of the rotational lines,population of energy levels, non-rigid rotation, anharmonicity and centrifugal distortion,effect of isotopic substitution. Rotation spectra of the linear, spherical top andasymmetric top polyatomic molecules, microwave technique **Infrared and Raman spectroscopy**	25%	15

	Types of vibration bands- overtones, combination bands, Fermi resonance phenomenon and the finger print region, FTIR spectroscopy and application. Rayleigh and Raman scattering, polarizabilities, rotational and vibrational Raman spectra, selection rules, polarization of the light and Raman effect, resonance Raman and coherent anti-Raman spectroscopy.		
4	**Environmental Chemistry** Chemical Speciation and toxicity of particulate, gaseous and soluble pollutants, remedial measures and methods to control industrial air pollution. Water Chemistry: Chemistry of water, concept of DO, BOD, COD, sedimentation, coagulation and filtration Soil Chemistry: Inorganic and organic components of soil, Nitrogen pathways and NPK in soils. Toxic Chemicals in the environment: Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon Monoxide, PAN Pesticides and Insecticides.	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

12. Quantitative Chemical Analysis by Daniel C. Harris
1. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch
2. Instrumental Methods of Analysis by Hobart H. Willard, Lynne L. Merritt, Jr., and John A. Dean
3. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch
4. Modern Analytical Chemistry by David Harvey

Semester: 3

- **Course Name:** Pericyclic reactions
  Course Code: 11205201
  Prerequisite: Pericyclic reactions are a class of organic reactions that involve concerted movement of electrons in a cyclic manner. These reactions follow specific rules governed by the conservation of orbital symmetry and are characterized by cyclic transition states.
  Rationale: Pericyclic reactions are a class of organic reactions that involve the simultaneous reorganization of electrons in cyclic transition states. These reactions occur in a concerted manner without the formation of intermediates. The rationale behind pericyclic reactions is based on several fundamental principles of molecular orbital theory and symmetry considerations.

Course Learning Objective:

CLOBJ1	Remember the fundamental principles of molecular orbital theory, particularly as it applies to pericyclic reactions. This includes comprehension of frontier molecular orbitals, their energies, symmetries, and interactions during these reactions.
CLOBJ2	Understand the Woodward-Hoffmann rules to predict the outcome and stereochemistry of pericyclic reactions. This involves understanding the symmetry considerations and orbital interactions that govern these reactions.
CLOBJ3	Apply and Developing the ability to recognize different types of pericyclic reactions, such as cycloadditions (e.g., Diels-Alder reactions), electrocyclic reactions, sigmatropic rearrangements, and their variations.
CLOBJ4	Analyse and Gaining insight into the mechanisms of pericyclic reactions, including the concept of concertedness, cyclic transition states, and the absence of intermediates.
CLOBJ5	Evaluate the feasibility, regioselectivity, and stereoselectivity of pericyclic reactions based on molecular structures, orbital symmetry, and reaction conditions.
CLOBJ6	Create synthetic applications of pericyclic reactions in organic synthesis. This includes their utility in building complex molecules, designing efficient synthetic routes, and manipulating molecular structures.

Course Learning Outcomes:

CLO 1	Remember Pericyclic reactions are a class of organic reactions involving concerted processes with cyclic transition states. They are characterized by their stereospecificity, regiospecificity, and concerted nature. Understanding pericyclic reactions is crucial in organic chemistry as they are involved in various synthetic transformations.
CLO 2	Understand pericyclic reactions from other types of organic reactions.
CLO 3	Apply the Woodward-Hoffmann rules and their significance in predicting the stereospecific and regiospecific outcomes of pericyclic reactions.
CLO 4	Analyse different types of pericyclic reactions (e.g., cycloadditions, electrocyclic reactions, sigmatropic rearrangements) based on their mode of operation and characteristics.

CLO 5	Evaluate the stereochemical consequences associated with pericyclic reactions, considering factors such as cis-trans isomerism and chiral induction, to predict and interpret stereochemical outcomes accurately.
CLO 6	Create applications of pericyclic reactions in industrial settings, recognizing their significance in the development of commercially valuable compounds and materials.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Pericyclic Reactions** Orbitals, molecular orbital symmetry, molecular orbital of ethylene, 1,3- butadiene, 1,3,5–hexatriene and allyl systems, concerted reactions, classification of pericyclic reactions, derivation of selection rules through construction of correlation diagrams for cycloaddition reactions and for electrocyclic reactions with 4n and 4n+2 p electrons, conrotatory and disrotatory motions for electrocyclic ring opening and ring closure. FMO approach for derivation of Woodward-Hoffman selection rules for cycloaddition and electrocyclic reactions, suprafacial and antarafacial cycloadditions. secondary effects and stereochemistry of cycloadditions; 2s+2a cycloaddition of ketenes.	29%	15
2	**Advanced Pericyclic Reactions** 1,3-Dipolar cycloaddition reactions, classification and applications. Sigmatropic reactions, suprafacial and antarafacial rearrangements, [1,j] sigmatropicrearrangement of hydrogen, [1,j] and [i,j] sigmaropic reactions of carbon, selection rules for [i,j] sigmatropic rearrangements using FMOs. The Cope and the Claisen rearrangements, fluxional tautomerism, the ene reaction, the Sommlet–Hauser rearrangement.	27%	15
3	**Photochemistry** Photo induced cis-trans isomerisation in olefins, photochemistry of vision, photochemistry of aromatic compounds and anilides. 1,2-, 1,3 - and 1,4- additions in benzene, photo-Fries rearrangement. Photolysis of nitrite esters; Barton reaction, dip- methane rearrangement, oxa-di-p-methane rearrangement, singlet oxygen oxygenations.	33%	15
4	**Free Radicals** Methods of generation of free radicals. Types of free radical, mechanism at aromatic substrate, reactivity in attacking radicals, free radical substitution reactions, halogenation, oxidation, coupling of alkynes and arylation of	11%	15

	aromatics with diazonium salts, Gomberg reaction, Sandmeyer reaction, Pschorr ring synthesis, Hunsdiecker reaction, Hoffmann–Loffler- Freytag reaction.		
	Total	**100%**	**60**

Text Book and Reference Book:

1. Pericyclic reactions-A Textbook: Reactions Applications and Theory Sankararaman; Wiley-VCH 2005
2. Pericyclic Reactions by S.M. Mukherjee
3. Photochemistry and Pericyclic Reactions by Jagdamba Singh & Jaya Singh; New Age Pubs.; II Edn. 2006
4. Pericyclic Reactions by G.B. Gill, M.R. Wills; Chapman and hall (1974)

- **Course Name:** Redox Reaction and Organometallics
  Course Code: 11205202
  Prerequisite: Understanding redox reactions and organometallic chemistry involves knowledge of various fundamental concepts in chemistry
  Rationale: The rationale behind redox reactions and organometallic chemistry lies in their significance across various fields of science, technology, and industry

Course Learning Objective:

CLOBJ 1	Remember the concept of oxidation and reduction and apply oxidation numbers to identify oxidizing and reducing agents.
CLOBJ 2	Understand Balancing Redox Equations
CLOBJ 3	Apply Redox in Electrochemistry
CLOBJ 4	Analyse real-world applications of redox reactions in energy storage, corrosion prevention, environmental remediation, and biological systems.
CLOBJ 5	Evaluate and understand the nature of organometallic compounds, including their structure, bonding, and reactivity.
CLOBJ 6	Create new application in coordination chemistry

Course Learning Outcomes:

CLO 1	Remember redox reactions, oxidation, reduction, and electron transfer.
CLO 2	Understand complex redox equations using appropriate methods like oxidation number balancing or the half-reaction method
CLO 3	Apply knowledge of redox reactions to predict and explain electrochemical processes, including cell potentials and spontaneous reactions
CLO 4	Analyze and discuss the role of redox reactions in everyday scenarios such as energy storage, corrosion prevention, environmental remediation, and biological systems
CLO 5	Evaluate oxidation and redox reactions.
CLO 6	Create application of redox reaction.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No.	Content	Weigh tage	Teachin g Hours
1	**Oxidation** Oxidation of olefins, alcohols, vicinal diols, ketones, aldehydes, oxidative decarboxylation, selective oxidation using reagents such as: oxygen, ozone, osmium tetroxide, lead tetra acetate, selenium dioxide, DDQ, peroxides, per acids, 9 chromium and manganese reagents, DMSO, Swern oxidation, DMDO, TEMPO, Prevost method, ruthenium tetroxide. Oppenauer oxidation.	29%	15
2	**Reduction** Principles of catalytic hydrogenation and metal hydride reductions, dissolving metal reductions, tri n-butyltinhydride, red aluminium and L and K selectride, selectivity in reductions, regiospecific reduction of alkenes, alkynes, aldehydes and ketones, Meerwein-Ponndorf-Verley reduction, reduction of μ,b-unsaturated compounds, epoxides, nitro and nitro so compounds.	27%	15
3	**Organometallics** Metal-ligand complexes, 18 electron rule. Use of palladium: Heck reaction, aromatic palladation, Suzuki coupling, Stille&Koumada coupling reactions, Sonogashira reaction, Wilkinsons catalysts, Wacker process. Cobalt complexes: Pauson–Khand reaction, Volhardt co-trimerization, hydroformylation using cobalt octacarbonyl. Use of titanium and ruthenium complexes: Tebbe reagent, Ziegler-Natta catalyst, Grubb's catalyst, olefin, ring closing and ring opening metathesis.	33%	15
4	**Name Reactions** Knovenagel condensation, Darzon condensation. Michael addition, Mannich reaction, Stork enamine synthesis, Baylis-Hillman reaction.	11%	15
	Total	100%	60

Text Book and Reference Book:

1. Comprehensive Organic Chemistry by D. Barton and W.D. Ollis
2. Advanced Organic Chemistry by Jerry March; Wiley India, 2007.; 4th Ed
3. Organic Reactions and their Mechanisms by P. S. Kalsi

- **Course Name:** Medicinal Chemistry

Course Code: 11205203

Prerequisite: A solid foundation in organic chemistry, biochemistry, and pharmacology, coupled with an understanding of drug design principles.

Rationale: Medicinal chemistry at the PG level requires a foundational knowledge in organic chemistry, biochemistry, and pharmacology to provide students with the essential skills and insights needed for the rational design, synthesis, and optimization of bioactive compounds with therapeutic potential, fostering a comprehensive understanding of drug discovery and development processes.

Course Learning Objective:

CLOBJ1	Remember principles of rational drug design, utilizing structure-activity relationships and computational methods for effective therapeutic agent development.
CLOBJ2	Understand advanced synthetic skills for designing and synthesizing organic compounds with pharmaceutical potential.
CLOBJ3	Apply and Gain insight into the molecular interactions between bioactive compounds and biological targets, informing the rational design of pharmacologically effective agents.
CLOBJ4	Analyse advanced assay techniques to evaluate the pharmacological effects of synthesized compounds.
CLOBJ5	Evaluate safety and toxicology aspects in medicinal chemistry to ensure the development of compounds with optimal pharmacological profiles.
CLOBJ6	Create effective engagement in interdisciplinary research and development within the dynamic field of medicinal chemistry.

Course Learning Outcomes:

CLO1	Remember drug design principles, showcasing the ability to design and optimize therapeutic agents through structure-activity relationships and computational techniques.
CLO2	Understand advanced synthetic skills by employing diverse methodologies for designing and synthesizing organic compounds with pharmaceutical relevance.
CLO3	Apply concept of molecular interactions between bioactive compounds and biological targets, facilitating informed decision-making in drug development.
CLO4	Analyse competence in performing and interpreting advanced biochemical and cellular assays, enabling the evaluation of pharmacological effects of synthesized compounds.
CLO5	Evaluate Integrate safety and toxicology considerations into medicinal chemistry practices, ensuring the development of compounds with favorable pharmacological and safety profiles.
CLO6	Create and demonstrate effective interdisciplinary collaboration skills, engaging in research and communication across diverse fields to contribute meaningfully to medicinal chemistry research and development.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**		
L	**T**	**P**	**C**	**Internal Evaluation**	**ESE**	**Total**

				MSE	CE	P	Theory	P	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Drug design**, **Pharmacokinetics and Pharmacodynamics:** Drug Design: Introduction, Concept of lead, Analogues and Prodrugs, An overview of drug design, development and discovery. Pharmacokinetics: Drug absorption, drug distribution, drug metabolism (general pathway of drug metabolism, oxidative, reductive and hydrolytic reactions). Pharmacodynamics: Receptors, chemical messengers, binding sites, receptor types and subtypes (protein receptors, DNA receptors with examples of agonists, partialagonists and anta agonists	**25%**	**15**
2	**Antimalarials and Cardiovascular Drugs:** Antimalarial Drugs: Malaria cycle, classification of antimalarials, quinine, chloroquine, primaquine, pamaquine, pyrimethamine and its analogues, proguanil, newer antimalarials, mefloquine and artesamic acid derivatives, structure-activity relationship and mode of action. Cardiovascular Drugs: Introduction, Main diseases of Cardiovascular system, Natural glycosides, digitalis, digitoxin, dobutamine hydrochloride, vasodilators, amyl nitrite, nitroglycerin, isosorbidedinitrate, nifedipine, verapamil, diltiazem, calcium channel blockers, dipyridamole, papaverine, cyclandelate. Antiarrhythmic drugs, procainamide hydrochloride, lidocaine hydrochloride, verapamil	**25%**	**15**
3	**Anticancer Drugs:** Introduction, mode of action, synthesis and uses of alkylating agents, nitrogen mustards, melphalan, chlormbucil, cyclophosphamide, 5- flurourocil, 6-mercaptopurine, mitomycinC. paclitaxel, capecitabine (prodrug), tamoxifen, camptothecin. Recent developments in cancer therapy, hormone therapy, gene therapy and natural products in cancer therapy.	**25%**	**15**
4	**Antibiotics & Psychoactive Drugs:** Antibiotics: General introduction, chemical classification, Synthesis of Pencillin, Ampicilin, Amoxylin. Tlactam antibiotics, aminoglycosides, tetracyclines, chloramphenicol. SAR and mode of action. Psychoactive drugs: Introduction, mechanism, effects and side effects of Antianxiety agents, antipsychotics, Antidepressant agents.	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Berger's Medicinal chemistry (Vol. 1-8) By J Abraham, Wiley | VII Edition
2. Medicinal Chemistry by AshutoshKar | New Age International Publishers
3. Synthetic Drugs by G. R. Chatwal
4. Instant Notes: Medicinal Chemistry By G. L Patrick | Viva Books

- **Course Name:** - Bioorganic Chemistry
  Course Code: 11205207
  Prerequisite: A solid foundation in organic chemistry, biochemistry, and pharmacology, coupled with an understanding of drug design principles.
  Rationale: Medicinal chemistry at the PG level requires a foundational knowledge in organic chemistry, biochemistry, and pharmacology to provide students with the essential skills and insights needed for the rational design, synthesis, and optimization of bioactive compounds with therapeutic potential, fostering a comprehensive understanding of drug discovery and development processes.

Course Learning Objective:

CLOBJ1	Remember principles of proteins, utilizing structure-activity relationships and computational methods for effective therapeutic agent development.
CLOBJ2	Understand advanced synthetic skills for designing and synthesizing organic compounds with pharmaceutical potential.
CLOBJ3	Apply and Gain insight into the molecular interactions between bioactive compounds and biological targets, informing the rational design of pharmacologically effective agents.
CLOBJ4	Analyse advanced assay techniques to evaluate the pharmacological effects of synthesized compounds.
CLOBJ5	Evaluate safety and toxicology aspects in medicinal chemistry to ensure the development of compounds with optimal pharmacological profiles.
CLOBJ6	Create effective engagement in interdisciplinary research and development within the dynamic field of medicinal chemistry.

Course Learning Outcomes:

CLO1	Remember proteins design principles, showcasing the ability to design and optimize therapeutic agents through structure-activity relationships and computational techniques.
CLO2	Understand advanced synthetic skills by employing diverse methodologies for designing and synthesizing organic compounds with pharmaceutical relevance.
CLO3	Apply concept of molecular interactions between bioactive compounds and biological targets, facilitating informed decision-making in drug development.
CLO4	Analyse competence in performing and interpreting advanced biochemical and cellular assays, enabling the evaluation of pharmacological effects of synthesized compounds.
CLO5	Evaluate Integrate safety and toxicology considerations into medicinal chemistry practices, ensuring the development of compounds with favorable pharmacological and safety profiles.
CLO6	Create and demonstrate effective interdisciplinary collaboration skills, engaging

	in research and communication across diverse fields to contribute meaningfully to medicinal chemistry research and development.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Carbohydrates and Lipids** Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides. Nacetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides-starch and glycogen. Carbohydrate metabolism-Krebs cycle, glycolysis, glycogenesis and glycoenolysis, gluconeogenesis, pentose phosphate pathway. Fatty acids, essential fatty acids, structure and function of triacyl glycerols. Glycerophospholipids, sphingolipids, cholesterol, bile acids, lipoproteins-composition and function, role in atherosclerosis. Properties of lipid aggregatesmicelles, bilayers, liposomes and their possible functions. Biological membranes. Fluid mosaic model of membrane structure.	25%	15
2	**Amino acids** Peptides, Proteins & Nucleic Acids Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing, Secondary structure of proteins, forces responsible for holding of secondary structures, ɲThelix, ʁTsheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein-folding and domain structure. Quarternary structure. Amino acid metabolism-degradation and biosynthesis of amino acids, sequence determination: chemical/enzymatic/mass spectral, recemization/detection. Chemistry of oxytocin and tryptophan releasing hormone (TRH) RNA and DNA Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA). Double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code.	25%	15
3	**Biosynthesis** Acetate hypothesis, sikimic acid pathway mevalonic acid pathway, biosynthesis of geranyl pyrophosphate and its conversion to ɲTpinene, thujene, borneol, menthone and carotenes. Biosynthesis of glycine, isoleucine, phenylalanine	25%	15

	and tyrosine. Nucleic acids, structure of DNA and RNA, role and significance of ATP and ADP. Structure and synthesis of peptides. Glycolysis, Crabs cycle & Oxidative Phosphorylation.		
4	**Enzymes and enzymatic processes** Introduction to enzymes, specificity and regulation, nomenclature, classification, concepts and identification of active sites by the use of inhibitors, mechanism of enzyme action, orientation and steric effects, specific examples of enzyme mechanism for chymotrypsin, ribonuclease and carboxypeptidase A, kinds of reactions catalysed by enzymes, some isomerization and rearrangement reactions, enzyme catalyzed carboxylation and decarboxylation, coenzymes, structure and biological functions of coenzyme A, thiamine pyrophosphate, NAD+, NADP+, techniques of immobilization of enzymes, applications of immobilized enzymes in food and drink industry	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Berger's Medicinal chemistry (Vol. 1-8) By J Abraham, Wiley | VII Edition
2. Medicinal Chemistry by AshutoshKar | New Age International Publishers
3. Synthetic Drugs by G. R. Chatwal
4. Instant Notes: Medicinal Chemistry By G. L Patrick | Viva Books

- **Course Name:** Spectroscopy of Organic Compounds
  Course Code: 11205204
  Prerequisite: Familiar about various spectroscopy and its applications
  Rationale: Identify structures of compounds using different spectroscopic method

Course Learning Objective:

CLOBJ 1	Remember 1H NMR spectroscopy and its applications
CLOBJ 2	Understand the concept of 13C NMR and its applications
CLOBJ 3	Apply concept of 1H NMR spectroscopy for elucidation of organic compounds
CLOBJ 4	Analyse conjugated dienes based on UV spectroscopy
CLOBJ 5	Evaluate the characteristics of Lanthenised shift reagents
CLOBJ 6	Create all spectroscopy techniques to elucidate structures of organic compounds

Course Learning Outcomes:

CLO 1	Remember spectroscopy in microwave, Rotational spectra of rigid diatomic molecules, selection rules
CLO 2	Understand structure of ESR absorption, Hyperfine structure, Double resonance in ESR
CLO 3	Apply NMR for elucidation of Organic Compound

CLO 4	Analyse 1H & 13C NMR spectroscopy
CLO 5	Evaluate ESR absorption, double resonance in ESR.
CLO 6	Create applications of spectroscopy.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Nuclear Magnetic Resonance (NMR) Spectroscopy:** Introduction, Magnetic properties of nuclei. Theory of NMR Spectroscopy. Chemical Shift. Factors affecting Chemical Shift. Shielding Mechanism. Spin ±Spin Splitting & its Mechanism. Vicinal coupling. Karpus equation. Coupling constant & conformation. Applications of 1H-NMR data (i). For elucidation of structure of organic molecules, (ii). Quantitative analysis, (iii).Study of hindered rotation & (iv) For inorganic chemistry problems: paramagnetic complexes, intramolecular tunnelling process.	25%	15
2	**Few important perceptions in NMR spectroscopy:** Chemical exchange reactions. Simplification of complex spectra: Shift reagents, Spin decoupling and Deuterium labeling. 13C NMR Spectroscopy: Introduction, 13C NMR Spectra - Scale, Solvents, Solvent signals & their positions, multiplicity. Chemical shift values for different functional groups in 13C NMR. Relaxation processes. Nuclear Overhauser Effect. Applications of 13C NMR data (including DEPT) to elucidate molecular structure & stereoisomers. 2D spectrum (COSY & HETCOR)	25%	15
3	**Electron Spin Resonance & UV-visible Spectroscopy:** Introduction, Relaxation process and line width. Hyperfine splitting: Factors affecting the magnitude of g values. Zero field splitting and Kramers degeneracy. Applications. Fundamentals of UV-Visible spectroscopy, types of electronic excitation, UV absorption by dienes, carbonyl, conjugated and extended conjugated system, aromatic system, calculation of Π to Π* transition in certain molecules	25%	15
4	**Applications involving miscellaneous spectroscopic techniques** Applications employing combined data from NMR, IR, Mass spectra and UV spectroscopy for elucidation of molecular structure.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. An Introduction to Spectrometric Method of Identification of Organic Compounds Vol I & II F. Scheinmann; Oxford Pergamon press, (1970)
2. Application of Absorption Spectroscopy of Organic Compounds J.R. Dyer; Prentice Hall of India, (New Delhi, 1964)
3. Organic Spectroscopy William Kemp; Macmillan Press, London 4. Spectroscopy of Organic Compounds P S Kalsi; W. Eastern, N. Delhi (1993).
4. Introduction of Mass spectroscopy F.W McLafferty, W.A Massachusetts, Benjamin; 2nd Edition
5. Spectroscopic Methods in Organic Chemistry D.H. Williams, I. Fleming; Tata McGraw-Hill, 2004
6. Organic Structural Spectroscopy J.B. Lambert, H.F. Shurvell, D.A Lightner, R.G. Cooks; Prentice-Hall, 1998

- **Course Name:** Lab I: Organic Preparation

Course Code: 11205208

Prerequisite: foundational understanding of organic chemistry principles, including functional groups, reactions, and basic laboratory techniques

Rationale: enhance students' problem-solving skills, reinforce theoretical concepts, and develop proficiency in various organic preparation techniques.

Course Learning Objective:

CLOBJ 1	Remember fundamental principles of organic synthesis, including reaction mechanisms, reagent selection, and purification techniques.
CLOBJ 2	Understand weighing, measuring, and mixing reagents, as well as using standard organic laboratory equipment.
CLOBJ 3	Apply multi-step organic syntheses, demonstrating the ability to adapt procedures based on experimental observations.
CLOBJ 4	Analyse spectroscopic and analytical techniques (e.g., NMR, IR, GC-MS) to characterize synthesized compounds and assess reaction efficiency.
CLOBJ 5	Evaluate laboratory procedures, including proper handling and disposal of reagents, adherence to safety protocols, and effective communication of hazards.
CLOBJ 6	Create multi-step organic syntheses, demonstrating the ability to adapt procedures based on experimental observations.

Course Learning Outcomes:

CLO 1	Remember organic synthesis principles and mechanisms.
CLO 2	Understand multi-step syntheses with a high degree of accuracy and reproducibility.
CLO 3	Apply and interpret spectroscopic data to identify synthesized compounds and assess the success of reactions.

CLO 4	Analyse critical thinking and troubleshooting skills to overcome challenges encountered during experimental procedures.
CLO 5	Evaluate spectroscopic data to identify synthesized compounds and assess the success of reactions.
CLO 6	Create organic synthesis principles and mechanisms

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**8**	**4**	**-**	**-**	**40**	**-**	**60**	**100**

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

Course Content:

Exp. No.	**Name of the Experiment**
1	Preparation of Salol
2	Preparation of yerayera
3	Preparation of p-amino benzene sulphonamide from aniline
4	Preparation of ethyl cinnamate
5	Preparation of Picric acid from Phenol
6	Preparation of benzoic acid from ethyl benzoate
7	Benzoic acid, b-napthol, m-dinitrobenzene
8	a-napthol, m-nitroaniline, anthracene
9	Tartaric acid, resorcinol, naphthalene
10	p-aminobenzoic acid, p-nitroaniline, benzophenone
11	Sulphanilic acid, cinnamic acid, a-napthol

Text Book and Reference Book:

1. Vogel's Textbook of Practical Organic Chemistry 5th ed
2. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, University Press

Semester: 4

- **Course Name:** Drugs and Natural Products
  Course Code: 11205251
  Prerequisite: To know basics about natural products their synthesis & uses, anti HIV agents.
  Rationale: Implement of natural product synthesis in industries.

Course Learning Objective:

CLOBJ1	Remember steroids, including human sex hormones their characteristics
CLOBJ2	Understand the concept of anti-viral agent. Analyze the symptoms of HIV. Understand the prevention & care of HIV.
CLOBJ3	Apply concepts of terpenoids & understand their properties. Classify Carrotenoids and understand their properties.
CLOBJ4	Analyze structures of alkaloids and understand their synthesis.
CLOBJ5	Evaluate the characteristics of amino acids. Classify amino acids.
CLOBJ6	Create a comprehensive understanding of vitamins and their synthesis by exploring the intricate pathways and processes involved in the production of these essential organic compounds.

Course Learning Outcomes:

CLO 1	Remember drug receptor interaction, drug uptake, transport, metabolism . Explain synthesis of drugs
CLO 2	Understand essential & non-essential aminoacids
CLO 3	Apply anti-HIV agent. Apply precautions to prevent from HIV
CLO 4	Analyse synthesis of different vitamins
CLO 5	Evaluate the impact of drug receptor interactions, drug uptake, transport, and metabolism on the overall pharmacological profile of therapeutic agents, considering factors such as efficacy, safety, and potential drug-drug interactions in a clinical context.
CLO 6	Create and understanding of drug development and usage, considering issues related to patient autonomy, informed consent, and the responsible conduct of research in the pharmaceutical industry.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No.	Content	Weigh tage	Teachi ng Hours
1	**Steroids and Antiviral agents:** Introduction, Nomenclature, numbering, double bond & Stereochemistry, Classification, mode of action, synthesis and uses of Testosterone, Androsterone and estradiol, Structure elucidation of Progesterone **Anti-viral agents**: Introduction to viruses, difference from bacteria, HIV & AIDS, synthesis and applications of thymidine,idoxyuridine, thiosemicarbazones, methisazone, pyrimidine derivatives, 2-thiouracils, acyclovir.	**25%**	**15**
2	**Alkaloids and Natural Pigments:** Alkaloids - Introduction, Structure determination- Nicotine, Morphine, Cocaine, Quinine. Synthesis and Stereochemistry of Ephedrine and Adrenaline Natural Pigments-Classification, Chemistry of anthocyanins, Structural elucidation of cyanin and pelargonin, Flavonol-Quercetin	**25%**	**15**
3	**Terpenoids and Alkaloids:** Terpenoids: Introduction, Classification of terpenes, general methods of structure elucidation, isoprene rule, structure elucidation of Camphor, santonin, Abietic acid, Zingiberene, Geraniol, Menthol, and Squalene. Carotenoids: Introduction, Structure and Synthesis of Carotene & Chlorophyll, Structures of Porphyrins & Haemin	**25%**	**15**
4	**Amino acids and Vitamins:** Amino acids Amino acids, Types, Classification of amino acids, Essential amino acids, Synthesis of amino acid, Reactions with Alkali, Alcohol, Sangers reagent, Edmanns reagent, Ninhydrin., Zwitter ions. Vitamins Introduction, Function, Deficiency, Daily requirement, Structure and Synthesis of vitamin A,Vitamin B1 (Thiamine),Vitamin B6 (Pyridoxine) and Vitamin H (Biotin),Synthesis of Vitamin C, Vitamin B Complex	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Organic Chemistry I L Finar
2. Organic Chemistry of Natural Products Chatwal; Himalaya; Vol 1 & 2
3. Berger Medicinal chemistry (Vol. 1-8) J Abraham, Wiley; VII Edition
4. Instant Notes: Medicinal Chemistry G. L Patrick; Viva Books
5. Medicinal Chemistry Principles and Practice F.D. King, RSC, 1994.
6. Medicinal Chemistry An Introduction G Thomas; John Wiley

- **Course Name:** Stereochemistry and Disconnection approach
  Course Code: 11205252
  Prerequisite: Understanding Stereochemical Relationships: A solid grasp of stereochemical concepts such as chirality, stereoisomerism, conformational analysis, and

methods to represent and manipulate stereochemical information (e.g., Fischer projections, Newman projections, wedge-dash notation) is fundamental.
Rationale: The disconnection approach in stereochemistry serves as a strategic method for simplifying complex molecules into simpler precursors or fragments, aiding in the planning and execution of synthetic routes.

Course Learning Objective:

CLOBJ 1	Remember principles of stereochemistry, including chirality, stereoisomerism, conformational analysis, and the different methods used to represent and manipulate stereochemical information.
CLOBJ 2	Understand disconnection approach specifically to stereochemical problems.
CLOBJ 3	Apply how to dissect complex stereochemical structures into simpler stereochemically defined fragments for synthetic planning.
CLOBJ 4	Analyze the ability to identify and prioritize bonds or functional groups critical to stereochemical outcomes when performing disconnections.
CLOBJ 5	Evaluate the impact of disconnections on stereochemical elements within a molecule.
CLOBJ 6	Create in predicting and rationalizing stereochemical outcomes resulting from different disconnections.

Course Learning Outcomes:

CLO 1	Remember the principles of retrosynthetic analysis to dissect complex stereochemical structures into simpler fragments using the disconnection approach.
CLO 2	Understand and prioritize bonds or functional groups crucial to stereochemical outcomes when performing disconnections, showcasing an understanding of stereochemical relevance.
CLO 3	Apply and rationalize stereochemical consequences resulting from different disconnections, considering the influence of various stereochemical elements on synthetic planning.
CLO 4	Analyse stereochemical considerations into synthetic planning using the disconnection approach.
CLO 5	Evaluate the experimental results to determine the efficiency and reliability of the proposed synthetic route.
CLO 6	Create a detailed experimental protocol to synthesize the target compound, considering optimal reaction conditions and potential challenges.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction:** Concept of synthon, synthetic equivalence, functional group Interconversion, concept and design of synthesis, criteria of good disconnection.	29%	15
2	**One group disconnection:** Disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivative.	27%	15
3	**Two group disconnection**: Disconnections in 1,3-dioxygenated skeletons, preparation of β-hydroxy carbonyl compounds , α, β- unsaturated carbonyl compounds 1,3-dicarbonyls, 1,5- dicarbonyls and use of Mannich reaction.	33%	15
4	**Disconnection and synthesis of α- hydroxyl carbonyl compounds** 1,2–diols, 1,4 and 1,6-dicarbonyl compounds. Pericyclic reactions:Disconnections based on Diels - alder reaction and its use in organic synthesis.	11%	15
	Total	100%	60

Text Book and Reference Book:

1. Stereochemistry and Mechanism through solved problems By P.S. Kalsi | Wiley Eastern Ltd
2. Stereochemistry: Conformation and Mechanism By P.S. Kalsi | New Age International (P) LTD
3. Stereochemistry of Carbon Compounds By E.L. Eliel | Tata McGraw-Hill Pub. Co. Ltd.
4. Stereochemistry of organic compounds By D. Nasipuri | New Age International (P) LTD
5. Designing Organic Synthesis By Stuart Warren, John Wiley & Sons (1994).

- **Course Name:** Chemistry of Heterocyclic Compounds
  Course Code: 11205253
  Prerequisite: The study of heterocyclic compounds, which are organic compounds containing a ring structure with at least one atom other than carbon in the ring, requires a foundation in various areas of organic chemistry. Here are some key prerequisites for the study of heterocyclic compounds.
  Rationale: The rationale behind having certain prerequisites for the study of heterocyclic compounds lies in the need to equip students with the foundational knowledge and skills necessary to understand the unique properties, reactivity, and applications of these compounds. Here are the key rationales for the mentioned prerequisites.

Course Learning Objective:

CLOBJ 1	Remember aromatic Spectroscopic Techniques for Characterization
CLOBJ 2	Understand the influence of reaction conditions on the selectivity of

	heterocyclic synthesis.
CLOBJ 3	Apply the Reactivity and Mechanisms of Heterocyclic Compounds
CLOBJ 4	Analyze the Role of Heterocyclic Compounds in Medicinal Chemistry
CLOBJ 5	Evaluate medicinal and pharmaceutical applications of heterocyclic compounds.
CLOBJ 6	Create novel approach to explore the reactivity and mechanisms of heterocyclic compounds.

Course Learning Outcomes:

CLO 1	Remember Heterocyclic Structures
CLO 2	Understand and predict aromaticity in different heterocyclic compounds. Synthesize Heterocyclic Compounds:
CLO 3	Apply synthetic routes for the preparation of specific heterocyclic compounds. Demonstrate an understanding of reaction mechanisms involved in heterocyclic synthesis. Reactivity and Mechanisms:
CLO 4	Analyze and predict the outcomes of key reactions involving heterocyclic compounds.
CLO 5	Evaluate the proficiency in applying synthetic routes, predicting reactivity, and understanding mechanisms by assessing the successful synthesis of specific heterocyclic compounds and accurate analysis of reaction outcomes in practical scenarios.
CLO 6	Create a systematic framework for investigating reactivity patterns and mechanistic insights in heterocyclic chemistry, fostering an innovative approach to designing synthetic routes and predicting outcomes in the synthesis of diverse heterocyclic compounds.

Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

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

Course Content:

Sr. No.	**Content**	**Weightage**	**Teaching Hours**
1	**Nomenclature** Hantzsch- Widman Nomenclature for fused heterocycles Six Membered Heterocycles containing Nitrogen Pyridines: Reactions and Synthesis Diazines- Pyridazine, Pyrimidine, and Pyrazine: Reactions and Synthesis	**25%**	**15**
2	**Bicyclic Hetrocycles containing Nitrogen** Quinoline and Isoquinoline: Synthesis and Reactions	**25%**	**15**

	Cinnoline, Quinazoline, Quinoxaline, and Phthalazine: Reactions and Synthesis Typical Reactivity of Indoles, Indoles & Substituted Indoles: Synthesis and Reactions		
3	**Heterocycles containing Oxygen** Pyryliums, 2- and 4-Pyrones: Synthesis and Reactions. Benzpyryliums and Benzopyrones: Reactions and Synthesis Chemistry of 1,3- and 1,2-azoles Imidazole and Pyrazole: Synthesis and Reactions	**25%**	**15**
4	**Supramolecular Chemistry** Introduction, host-guest interaction, classification of host-guest compounds, intermolecular forces, nature of Supramolecular interactions, molecular recognition, chiral discrimination, molecular receptors, and design principles, template effect, cryptands, cyclodextrins, catenanes, and rotaxanes, molecular capsules, molecular self-assembly.	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Heterocyclic chemistry, J. A. Joule and K. Mills , 5thedition, Wiley- Blackwell Publishing Ltd.
2. Heterocyclic chemistry, Thomas L. Gilchrist 3rd edition, Prentice Hall. Handbook of Heterocyclic Chemistry, 3rd edition, A. R. Kartrizky, C. A. Ramsden, J. A. Joule, and V. Zhdankin,Elsevier.
3. Name Reactions in Heterocyclic Chemistry,Jie Jack Li, Wiley Interscience.
4. Supramolecular chemistry: Concepts and Perspectives,J. M. Lehn, Wiley.
5. Supramolecular chemistry,2ndEdition,J.W. Steed, J. L. Atwood, Wiley.
6. Principles and methods in Supramolecular chemistry,H-J Schneider, A Yatsimirsky, John Wiley & Sons Inc, United States.

- **Course Name:** Industrial Chemical Processes
  Course Code: 11205281
  Prerequisite: Familiar with the synthesis of Industrial chemical processes & their uses
  Rationale: Implement of synthetic techniques of processes industry.

Course Learning Objective:

CLOBJ 1	Remember concept of Industrial Chemical Processes and constitution theories.
CLOBJ 2	Understand the concept of Industrial Chemical Processes in dyes, understand
CLOBJ 3	Apply knowledge sources, applications & constituents.
CLOBJ 4	Analyse the synthesis of processes.
CLOBJ 5	Evaluate the characteristics of Chemical process.
CLOBJ 6	Create modern uses of dyes, textile dyes, dyes for foam and plastics.

Course Learning Outcomes:

CLO 1	Remember Nitrogen, Chlor-Alkali Industry & Industrial Gases.

CLO 2	Understand the Electrochemical-Thermal, Fermentation, Agrochemical & Pesticides Industry.
CLO 3	Apply information about the brightening agent.
CLO 4	Analyse different dyes suitable to different substracts.
CLO 5	Evaluate the mastery of Unit Processes-I.
CLO 6	Create an assessment framework to Quality Control & Safety Hazardous.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	Nitrogen, Chlor-Alkali Industry & Industrial Gases Nitrogen Industry Manufacture of synthetic nitrogen products and miscellaneous chemicals such as ammonia, hydro amine, iodine, fluorine, fluorocarbon and various types of nitrogenous fertilizers such as urea, ammonium sulphate, ammonium nitrate, calcium ammonium nitrate.· Chlor-Alkali Industry & Industrial Gases Manufacture of Chlor-alkali chemicals, caustic soda by membrane cell method and by lime soda process, soda ash, sodium hypochlorite and chlorine. Industrial Gases –Hydrogen, Oxygen, Nitrogen, Carbon dioxide, Sulphur dioxide..	25%	15
2	Electrochemical- Thermal, Fermentation, Agrochemical & Pesticides Industry Electrochemical-Thermal Industry Manufacturing of silicon carbide, calcium carbide, boron carbide, boron nitride, synthetic graphite, carbon electrode, magnesium anhydrous, MgCl2, MgO, hydrogen peroxide, potassium permanganate, hydroxyl amine. Fermentation Industry Fermentation-culture development, inoculums preparation, nutrients for micro-organism, toxic effects on culture, manufacture of industrial alcohol, absolute alcohol, vinegar, downstream processing. Agrochemical & Pesticides Industry Manufacture of phosphorus, phosphoric acid, ammonium phosphate, super phosphate. Introduction to Agrochemical and pesticides.	25%	15
3	Unit Processes-I Nitration: nitrating agents, mechanism, batch v/s continuous nitration process and manufacturing of Nitrobenzene (batch and continuous), mdinitrobenzene and p-nitro acetanilide. Sulfonation: sulfonating agents, mechanism and commercial manufacturing of benzene sulfonic acid (Barbet process) and Naphthalene sulfonic acid.	25%	15

	Halogenations: mechanism and manufacturing of BHC and Chlorobenzene. Hydrolysis: hydrolyzing agents and different mechanism of Hydrolysis. Esterification: mechanism and commercial manufacturing of Ethyl acetate		
4	Unit Processes-II, Quality Control & Safety Hazardous Oxidation: types of oxidation reaction, oxidizing reagents and commercial manufacturing of Benzoic acid, Phthalic anhydride and Acetic acid. Reduction: amination by reduction and by ammonolysis. Different types of reduction reactions and manufacturing of Aniline by Bechamp reduction, m-nitro aniline and Aniline by ammonolysis. Quality Control & Safety Hazardous Quality control of products, concept of quality, important of quality, quality decision, quality management, quality cost, quality assurance, reliability, economics of manufacturing, costing, social and human values, ISO 9001: 2000. Industrial hazards and safety considerations in chemical industries, mechanical, electrical and chemical hazards, fire and explosion hazards, health hazards, laboratory safety, control of plant hazards, safety practice.	**25%**	**15**
	Total	**100%**	**60**

Text Book and Reference Book:

1. Industrial Chemistry by B. K. Sharma
2. Unit operation-I by K.A. Gavhane, Nirali Prakashan
3. Unit operation-II by K.A. Gavhane, Nirali Prakashan

- **Course Name:** Synthetic Dyes
  Course Code: 11205280
  Prerequisite: Familiar with the synthesis of dyes, azodyes, NIR dyes & their uses
  Rationale: Implement of synthetic techniques of dyes in industry.

Course Learning Objective:

CLOBJ 1	Remember concept of dyes, including different colour and constitution theories.
CLOBJ 2	Understand the concept of hydrogen bonding in dyes, understand NIR dyes.
CLOBJ 3	Apply knowledge of dyes based sources, applications & constituents.
CLOBJ 4	Analyze the synthesis of azo dyes.
CLOBJ 5	Evaluate the characteristics of azo dyes, biodegradability of azo dyes & toxicity of azodyes.
CLOBJ 6	Create modern uses of dyes, textile dyes, dyes for foam and plastics.

Course Learning Outcomes:

CLO 1	Remember various uses of dyes.
CLO 2	Understand the synthesis of dyes.

CLO 3	Apply information about the brightening agent.
CLO 4	Analyse different dyes suitable to different substracts.
CLO 5	Evaluate the mastery of heterocyclic structures, the ability to predict aromaticity, and the proficiency in synthesizing specific compounds.
CLO 6	Create an assessment in designing innovative synthetic approaches.

Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

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

Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction & Near Infrared Absorption (NIR) dyes:** Important Chemical chromophores of dyes. Classification of dyes. Description of individual class and principle applications of each class. Near Infrared Absorption (NIR) dyes Introduction, Cyanine type chromophores, donor-acceptor chromophores, applications.	25%	15
2	**Synthesis of functional dyes Fluorescent brightening agents:** Molecular orbital design. Characteristics and synthesis of functional dyes for electro-optical applications. Characteristics of brightening agents and its applications	25%	15
3	**Azo dyes:** Physical properties, structure, and bonding, synthesis of hydroxy Azo dyes and metal complex Azo dyes, Toxicity of Azo Dyes, Azo pigments, Biodegradation of Azo dyes, colour and constitution: early and modern theories.	25%	15
4	**Non textile dyes:** Colour photography: the dye forming process, yellow dyes, magenta couplers, cyan couplers, dye bleach process, image diffusion process. Electronic use of dyes: electrophotography, laser dyes, liquid crystal dyes, solar cells. Biological uses: dyes as drugs, food dyes. Dyes for plastic and foams.	25%	15
	Total	100%	60

Text Book and Reference Book:

1. Colour Chemistry: Synthesis, properties and applications of organic dyes and pigments,Heinrich Zollinger, John Wiley & Sons.
2. Modern colorants: synthesis and structure, (Advances in Color Chemistry Series, Volume 3, A.T. Peters and H. S. Freeman, Springer Netherlands.

3. The chemistry of synthetic dyes and pigments, The production and applications of fluorescence brightening agents, Milos Zahradnik,John Wiley & Sons Australia, Limited.
4. Infrared absorbing dyes Masaru Matsuoka, Springer-Verlag New York Inc.