VIDHYADEEP UNIVERSITY

Syllabus of M.Sc. Organic Chemistry

Effective from 2022-2023

Teaching & Evaluation Scheme Semester – I & II

Course name: Master of Science (Organic Chemistry)		**Semester I**						
Grade System:								
Subject			Teaching Scheme		Examination Scheme		Passing Scheme	Total Marks
Code	Paper No.	Paper Title	Hours/ week	Credit	Theory		Passing Head	
			Theory	Theory	Internal	External		
1171101	CY101	Inorganic Chemistry - I	4	4	30	70	40	100
1171102	CY102	Organic Chemistry- I	4	4	30	70	40	100
1171103	CY103	Physical Chemistry - I	4	4	30	70	40	100
1171104	CY104	Analytical Chemistry - I	4	4	30	70	40	100
1171105	CY105	Practicals	12	8	60	140	80	200

Course name: Master of Science (Organic Chemistry)		**Semester II**						
Grade System:								
Subject			Teaching Scheme		Examination Scheme		Passing Scheme	Total Marks
Code	Paper No.	Paper Title	Hours/ week	Credit	Theory		Passing Head	
			Theory	Theory	Internal	External		
1171201	CY201	Inorganic Chemistry - II	4	4	30	70	40	100
1171202	CY202	Organic Chemistry - II	4	4	30	70	40	100
1171203	CY203	Physical Chemistry - II	4	4	30	70	40	100
1171204	CY204	Analytical Chemistry - II	4	4	30	70	40	100
1171205	CY205	Practicals	12	8	60	140	80	200

VIDHYADEEP UNIVERSITY

VIDHYADEEP INSTITUTE OF SCIENCE, ANITA (KIM)

DEPARTMENT OF CHEMISTRY

Program Outcome	PO1: The aim is to augment one's knowledge in the various domains of chemistry and attain mastery in the chosen branch of the field, while also fostering clear and effective communication within and across disciplinary boundaries. PO2: Develop entrepreneurial skills by leveraging the industrial hub situated in the vicinity of our university. PO3: Establish a research center with the support of interdisciplinary subjects offered at the university. PO4: Pursue a doctoral degree in the Organic Chemistry and continue further studies. PO5: Develop short-term courses relevant to the demanded subject to enhance knowledge and its practical application. PO6: Provide training/internship opportunities to students for employment in public and private sectors, as well as national laboratories. PO7: Engage in scientific discourse with a respectful demeanor and take the lead in interdisciplinary & multidisciplinary collaborations with experts from diverse fields. PO8: Acquire knowledge and implement best safety practices in chemical research & Industry.

Objective of Program	The primary goal of the M.Sc. Organic Chemistry program is to equip students with the skills and knowledge necessary to pursue dynamic careers in industry and academia by offering a superb teaching and research environment in both core and emerging areas of the discipline.

Program Specific Outcomes	PSO1: Foster a scientific mindset and convey scientific knowledge with clarity, brevity, and accuracy. PSO2: Explore employment prospects in the chemical sector, including dye and pharmaceutical industries, as well as national laboratories and research centers, at all hierarchical levels. PSO3: Utilize expertise in sustainable and environmentally-friendly technologies. PSO4: Develop a capacity for logical reasoning to effectively tackle issues and achieve outcomes. PSO5: Fostering a research-oriented culture to promote Ph.D. programs at national and international institutes/universities. PSO6: Engage in targeted competitive exams organized by public service commissions and other governmental agencies. PSO7: Acquire and employ foundational knowledge to establish small-scale industries in the context of the self-reliant India (Atma Nirbhar Bharat) initiative. PSO8: Increase the production scale of synthetic products from laboratory to pilot-level plant, and subsequently to bulk production. PSO9: Promote a scientific mindset among students in preparation for cultivating a research culture and implementing policies at both the global and local levels. PSO10: Articulate scientific information clearly through both written and oral communication. PSO11: Students can improve their reading, thinking, and learning abilities in their field by refining their ideas through writing. PSO12: Engaging in scientific practices during an investigation offers students the chance to express their thoughts, leading to the creation of novel scientific insights.

Mapping between POs and PSOs		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO1 0	PSO1 1	PSO1 2
	PO 1		✓	✓			✓	✓	✓	✓	✓	✓	
	PO 2	✓		✓		✓		✓	✓	✓	✓	✓	✓

	PO 3	✓		✓	✓	✓				✓	✓	✓	✓
	PO 4	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓
	PO 5		✓	✓	✓			✓			✓		✓
	PO 6	✓		✓	✓	✓	✓			✓	✓		✓
	PO 7		✓	✓	✓	✓			✓		✓		✓
	PO 8	✓	✓		✓			✓	✓	✓		✓	✓

M.Sc. (Organic chemistry)

SEM-1

CY101: Inorganic Chemistry – I (Total Hr: 60)

Course Objectives:	CO1: To provide students with an understanding of the fundamental concepts and applications of symmetry and group theory in chemistry. CO2: To provide an understanding of the unique properties and applications of solvents such as liquid ammonia, sulfur dioxide, and supercritical fluids, and how they can be used in organic synthesis and other chemical reactions. CO3: To develop understanding of the principles of nuclear structure, nuclear reactions, and radioactive decay, as well as their applications. CO4: To provide an understanding of the synthesis, properties, and applications of polymers that contains inorganic elements as well as their potential use. CO5: To develop understanding of the magnetic properties of materials and how these properties can be used to study the electronic structure and bonding of molecules.

Mapping between CO and		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO10	PSO11	PSO12
	CO 1	✓			✓	✓	✓				✓	✓	
	CO 2	✓	✓			✓	✓				✓	✓	

PSO	CO 3	✓				✓	✓				✓	✓	
	CO 4	✓	✓			✓	✓				✓	✓	
	CO 5	✓				✓	✓				✓	✓	

Unit-I Symmetry and group theory in chemistry 15 hr

Concept of symmetry and its operations, Symmetryelements: Rotation axis of symmetry and improper rotational axis of symmetry, Planeof symmetry, Definition and notation ofpoint groups, Classification of molecules into point groups, Symmetry and Dipolemoment, Symmetry criteria for optical activity, Reducible and Irreducible representations and their relation,Orthogonality theorem, Preparation of character table for C_{2v} and C_{3v} point groups, Type of matrix and its examples.

Unit-II

Chemistry of non-aquous solvent and Nuclear Chemistry 15 hr

Chemistry of non-aquous solvent: Classification of solvents, Characteristic properties of solvents, Leveling Effect, Various types of reactions in solvents, Chemistry of liquid ammonia, liquid hydrogen fluoride, liquid sulfur dioxide and anhydrous sulphuric acid with respect to properties, solubilities and reactions.

Nuclear Chemistry: Radioactive decay and equilibrium, Nuclear reactions, Q value, Cross-sections, Types of reactions, Chemical effects of nuclear transformation, Fission and Fusion, Fission products and Fission yield

Unit-III

Inorganic Polymers 15 hr

Definition of polymers and their depiction, Characteristics of inorganic polymer, Characterization of inorganic polymers: molecular weight, Number average and weight average, Determination of molecular weight by viscometry and osmometry, Structural features of polymer: (i) Backbone bonding, (ii) Branching and Cross-linking (iii) Chemical and stereo chemical variability, Classification of inorganic polymer, Synthesis, properties, structure and uses of polyphosphazene and polysiloxanes

Unit-IV

Elements of magnetochemistry 15 hr

Definition of magnetic properties, Sources of paramagnetism, diamagnetic, Magnetic susceptibility and basic derivation of diamagnetic susceptibility, Determination of magnetic susceptibility by Gouy method, Faraday method and Null deflection method, Pascal's constant, example of pascal's constant, Curie law and Curie-Weiss law, Antiferromagnetism and ferromagnetism, Orbital contribution to magnetic moment, Calculation of spin magnetic moment, Anomalous magnetic moment, Magnetic exchange coupling and Spin Crossover. Magnetic properties of inner transition metal complexes and their spin & orbital moments.

Reference Books:

1. Chemical Applications of group theory by F. A. Cotton, Wiley Estern Limited.
2. Group theory and symmetry by L. R. Hall, McGraw Hill.
3. Group theory and its Applications by P. K. Bhattacharya, Himalaya Publishing House.
4. Chemistry in non-aqueous solvents by H. S. Sisler, Reinhold Publishing Corporation.
5. Essentials of Nuclear chemistry by H. J. Arniker, New age International publishers.
6. Descriptive Inorganic chemistry by J. E. House, K. A. House, Elsevier.
7. Introductory polymer chemistry by G. S. Mishra, Wiley Estern limited.
8. A text book of Inorganic Polymers by G. R. Chatwal, Himalaya Publishing House.
9. Inorganic Polymers by P. B. Saxena, Discovery Publishing House.
10. Introduction to magnetochemistry by A. Earnshaw, Elsevier.
11. Elements of Magnetochemistry by R. L. Dutta, A. Syamal, Affiliated East-West Press.
12. Inorganic Chemistry, J.E. Huheey, K.A.Keiter and R.L.Keiter, Harper Cottens College Publications.

Course Outcome : After finishing this course, the student will have the ability to	
1.	Understand of the fundamental concepts and applications of symmetry and group theory in chemistry
2.	Developed an appreciation for the distinctive characteristics and practical uses of solvents, such as liquid ammonia, sulfur dioxide, and supercritical fluids, in organic synthesis and other chemical reactions.
3.	Developed a comprehension of the principles governing nuclear structure, nuclear reactions, and radioactive decay, as well as their practical applications.
4.	Developed knowledge regarding the synthesis, properties, and applications of polymers containing inorganic elements, as well as their potential uses.
5.	Developed a comprehension of the magnetic properties of materials and their potential applications in studying the electronic structure and bonding of molecules.

CY102: Organic Chemistry – I (Total Hr: 60)

Course Objectives:	CO1: To explain the mechanism and predict the products of electrophilic and nucleophilic substitution reactions on both aromatic and aliphatic compounds. CO2: To describe and analyze the properties, reactions, and synthetic applications of various reactive intermediates. CO3: To equip the knowledge of the fundamental reagents and name reactions used in organic chemistry, enabling them to recognize and apply these in various synthetic transformations. CO4: To understand and apply the principles of stereochemistry to predict, explain, and control the stereochemical outcomes of chemical reactions.

Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	✓	✓		✓	✓		✓		✓	✓	✓	✓
	CO2	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
	CO3	✓				✓	✓				✓	✓	
	CO4	✓	✓			✓	✓				✓	✓	

Unit-I

Aromatic & aliphatic substitution reactions (Electrophilic and Nucleophilic) 15 hr

Mono-substituted benzenes- Reactivity and orientations, Orientation in benzene rings with more than one substituent, Ipso substitution, Orientation in other ring systems, Mechanisms of fridel-craft reactions, Nitration, Sulphonation, Halogenation, Diazo coupling and Formylation. Benzyne mechanisms for aromatic nucleophilic substitution reactions. Introduction to S_N2, S_N1, mixed S_N1 and S_N2. S_Ni and SET mechanisms. The neighbouring mechanism, Neighbouring group bonds, Anchimeric assistance. Reactivity σ and π participation by effects of substrate, attacking nucleophile, leaving group and reaction medium, Phase transfer catalysis and ultrasound, Ambient nucleophile, Regioselectivity. Bimolecular mechanisms - S_E2 and S_Ei. The S_E1 mechanism, Electrophilic substitution accompanied by double bond shifts. Effect of substrates, Leaving group and the solvent polarity on the reactivity.

Unit-II

Reactive intermediates: 15 hr

Generation, structure, stability and reactions of carbocations (classical and non classical): Phenonium ion, norbornyl system, Common carbocation rearrangement: Pinacol-pinacolone rearrangement. Beckmann rearrangement.

Generation, structure, stability and reactions of carbanions: mechanism of condensation involving enolates: aldol condensation, benzoin reaction, dieckmann reaction, common; carboanion rearrangement: benzil-benzilic acid rearrangement.

Generation, structure, stability and reactions of carbenes:common carbenes rearrangement: wolff rearrangement.

Reactions of free radicals: Allylic halogenations (NBS),coupling of alkenes and arylation of aromatic compounds by diazonium salts. Sandmayer reactions, Hunsdiecker reaction.

Unit-III

Advances in Reagents and name reactions-I: 15 hr

Reagents in organic synthesis [oxidation] : General introduction of organic oxidation protocols; Utility of following reagents in organic synthesis, CrO_3, PCC, PDC, MnO_2, $KMnO_4$, SeO_2, $Pb(OAc)_4$, OsO_4, HIO_4, DMSO, H_2O_2, Ozone, HgO, NBS, $K_3Fe(CN)_6$, DDQ, $Al(O\text{-}t\text{-}Bu)_3$, hypervalent iodine named reactions: reimer-tiemann reaction, michael reaction, hell-volhard-zelinski reaction, chichibabin reaction.

Unit-IV

Stereo Chemistry 15 hr

Optical and geometrical isomerism, origin of chirality and chiral centre, axis and plane, helicity, Enantiotopic and diastereotopic atoms, Groups and faces, Prochiral centre, Biphenyl, Allenes, Spirans, Compounds containing chiral nitrogen and sulfur, Stereospecific and stereoslective synthesis, Dynamic resolution.

Reference Books:

1. Organic Chemistry by G. Marc. Loudon, Oxford University
2. Organic Chemistry by J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University
3. Advanced Organic Chemistry (4^{th} edition) by Jerry March.
4. Organic Chemistry by Morrission and Boyd, Prentice Hall Pvt. Ltd.
5. A Text Book of Organic Chemistry by R. K. Bansal, New Age International Ltd.
6. Stereochemistry of Organic Compounds by Ernest L. Eliel, Samuel H. Wilen, Wiley.
7. Advanced Organic Stereochemistry by Nimai Tewar, Books and allied (P) Ltd.

Course Outcome : After finishing this course, the student will have the ability to	
1.	Explain the mechanism and predict the products of electrophilic and nucleophilic substitution reactions on both aromatic and aliphatic compounds, design and conduct experiments to verify predicted products, analyze the effects of substituents, evaluate limitations, and apply their knowledge to solve problems.
2.	Describe the properties, reactions, and synthetic applications of various reactive intermediates and analyze their behavior in chemical reactions.

3.	Recognize, apply and integrate fundamental reagents and name reactions used in organic chemistry for various synthetic transformations.
4.	Understand and apply the principles of stereochemistry to predict, explain, and control the stereochemical outcomes of chemical reactions, enabling them to design and execute efficient and selective synthetic strategies.

CY103: Physical Chemistry –I (Total Hr: 60)

Course Objectives:	CO1: To provide students with a comprehensive understanding of the laws, concepts, and applications of energy and entropy in various physical and chemical systems. CO2: To enable students to understand and analyze the rates and mechanisms of chemical reactions and to apply this knowledge to solve problems related to chemical kinetics. CO3: To provide students with an understanding of the physical and chemical properties of colloids, their behavior in different environments, and their applications in various fields. CO4: To familiarize students with the physicochemical properties and behavior of surfaces and interfaces, including their interactions with molecules, ions, and nanoparticles, and their applications in catalysis, materials science, and environmental science.

Mapping between CO and PSO		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO10	PSO11	PSO12
	CO 1	✓	✓			✓		✓		✓	✓	✓	
	CO 2	✓	✓	✓			✓	✓	✓	✓	✓	✓	
	CO 3	✓			✓		✓		✓		✓	✓	✓
	CO 4	✓				✓	✓				✓	✓	✓

Unit-I
Thermodynamics **15 hr**

Introduction to Laws of thermodynamics, State and path functions and their applications, Thermodynamic description of various types of processes, Maxwell's relations, Partial molar quantities, Gibbs Helmholtz equation, Chemical potential, Gibbs Duhem equation, Variation of chemical potential with temperature and pressure, Determination of partial molar volume and partial molar enthalpy, Nernst heat theorem, Boltzmann entropy equation

Unit – II
Chemical Kinetics–I **15 hr**

Rate of reactions, Rate law and the rate constant, Order of reaction, Units of rate constant, Integration of First, Second, Third and zero order reactions, Half life time of a reaction, Molecularity of reactions, Effect of temeperature and catalyst reactions, Arrhenius equation, Collision theory of bimolecular gaseous reactions, Activated complex theory(ACT) of bimolecular gaseous reactions, Numericals.

Unit - III
ColloidChemistry **15 hr**

Adsorption, colloids, Micellization, Hydrophobic interaction & properties(DLVO theory & The electrical double layer), Electrokinetic properties(Electrophoresis), Surface active agents, Classification of Surface active agents, HLB(Hydrophile-Lipophile balance), Critical micellar concentration (CMC), Factors affecting the CMC of surfactants, Thermodynamics approach to CMC, Thermodynamics of Micellization, Solubilization,
Micellular catalysis, Types of Emulsions: Macroemusion and Microemulsion, Gels, Applications of colloids.
Gibbs adsorption isotherms and the determination of surface area/molecule, Estimation of surface area of adsorbents (BET equation), Surface films on liquids, Electrical double layer, Zeta potential and its determination by electrophoresis, Effect of salt on zetapotential,catalytic activity at surfaces. Numericals.

Unit – IV
SurfaceChemistry **15 hr**

Adsorption, Applications of adsorption, The Freundlich Adsorption Isotherm, Desorption Activation Energy, The Langmuir theory of Adsorption, BET equation, Gibbs adsorption isotherm, Cappilary active and inactive solutes, Insoluble surface films on liquids, Langmuir film balance, Surface film pressure, Modern techniques for investing surfaces: LEED(Low Energy Electron Diffraction), PES(Photo Electron Spectroscopy), STM(Scanning Tunnelling Microscopy), EXAFS(Extended X- ray Adsorption Fine Structure) and SEXAFS (Surface Extended X-ray Adsorption Fine Structure)

Reference books:

1. Physical Chemistry by P. W. Atkins, ELBS.
2. Upkar's CSIR-UGC NET/JRF/SLET - ChemicalScience.
3. Principles of Physical Chemistry by Puri, Sharma &Pathania, Vishal Publishing co.
4. Micelles, Theoretical and Applied Aspects by V. Moroi,Plenum, Springer.
5. A Textbook of Physical Chemistry by K. L. Kapoor, McGraw Hill.
6. Micelles, Theoretical and Applied Aspects by V. Morol, Plenum.
7. Introduction to Colloid and Surface Chemistry by Shaw, Butterworth-Heinemann.

8. Physical Chemistry by Protuonand Marron, CBS Publishers and Distributors Pvt Ltd.

Course Outcome : After finishing this course, the student will have the ability to	
1.	Comprehensive understanding of the laws, concepts, and applications of energy and entropy in various physical and chemical systems, and be able to apply this knowledge to analyze and predict the behavior of complex systems.
2.	Understand and analyze the rates and mechanisms of chemical reactions and apply this knowledge to solve problems related to chemical kinetics, including the design and optimization of chemical processes.
3.	Understanding of the physical and chemical properties of colloids, their behavior in different environments, and their applications in various fields, enabling them to design and develop new materials and processes that utilize colloids.
4.	Familiarized with the physicochemical properties and behavior of surfaces and interfaces, including their interactions with molecules, ions, and nanoparticles, and their applications in catalysis, materials science, and environmental science, enabling them to design and develop novel materials and processes that utilize surfaces and interfaces.

CY104: Analytical Chemistry – I (Total Hr: 60)

Course Objectives:	CO1: To equip students with the necessary skills and knowledge to apply mathematical and statistical methods to analyze chemical data and solve problems in fields of chemistry. CO2: To enable students to develop a deep understanding of the principles, instrumentation, and applications of various chromatographic techniques used for separation, identification, and quantification of chemical compounds in complex mixtures. CO3: To provide students with a solid foundation in the theory, principles, and applications of UV-Visible spectroscopy for the analysis of electronic transitions and concentration of molecules in various chemical system. CO4: To enable students to understand the theory, principles, and applications of infrared spectroscopy for the analysis of molecular vibrations and structures in various chemical systems.

Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	✓	✓			✓		✓		✓	✓	✓	
	CO2	✓	✓		✓		✓		✓	✓	✓	✓	
	CO3	✓	✓	✓	✓			✓			✓	✓	
	CO4	✓	✓			✓			✓		✓	✓	

Unit-I Chemometrics **15 hr**

Quantitative analysis, Selecting Analytical method, data recording, Statistical treatment to analytical data, nature of quantitative data available in analytical laboratories, accuracy and precision, errors and types of errors. Significant figures, standard deviation, and confidence limit, test of significance: t and Q test, numericals. Statically aids of hypothesis testing, detection of gross errors, estimation of detection limits, least square methods for deriving calibration plots, quality assurance and control charts, principal component analysis, factorial design, response surface design, multivariate calibration, multiple linear regression, principal component regression.

Unit-II Chromatography methods **15 hr**

Classification of chromatographic methods. Principle of gas chromatography, GSC and GLC, HPLC.

GC: Instrumentation, Mobile phase and its characteristics, Chromatographic columns, stationary phase and its characteristics, Sample injection systems, detectors: FID, TCD and ECD, Characteristics of ideal detectors.

TLC: Stationary and mobile phase in TLC, Methods of preparation of TLC, Detecting system of TLC quantitative TLC, Preparative TLC paper chromatography, One and two-dimensional chromatography, Detection of paper and TLC**.**

HPLC: Principle and instrumentation, Mobile and stationary phases and detectors. Quantitative analysis.

Unit – III
UV-Visible spectroscopy **15 hr**

Molecular spectroscopy, Measurement of transmissions and absorbance, Types of molecular energies, Electronic spectra and molecular structure, Electronic energy levels, Electronic transitions and selection rules, Designation of UV bands, Absorption Law and measurement of absorption intensity, Beer's –Lambert law, Chromospheres and Auxochromes, red and blue shifts Woodward fieser rule for structure elucidation of organic molecule, UV-VIS instrumentation.

Unit – IV Infrared spectroscopy **15 hr**

IR Spectroscopy: Introduction to IR spectrometry, Theory of IR absorption spectrometry, basic principle, vibrational–rotational transitions, types of molecular vibrations, Vibrational Coupling, Infrared spectrum, Functional group and finger print regions, absorption frequencies of different functional groups of organic molecules, Fundamental vibrations, combination bands and overtones, selection rules. Instrumentation of and IR spectrophotometer, sources and detectors.

FTIR Spectroscopy: FTIR spectrophotometer, principle and instrumentation, Sampling methods, Reference and solvents, structure elucidation using FTIR data.

Reference books:

1. Analytical Chemistry by Gary Christian, John Wiley & Sons Inc.
2. Principles of Instrumental Analysis by Skoog. Holler, Nieman, Harcourt College publishers.
3. Instrumental Methods of Analysis by Willard, Merit, Dean, CBS Publishers &distributors.
4. Electronic Absorption Spectroscopy and related techniques by D. N. Satyanarayana, University Press.
5. Separation Methhods by M. N. Sastri, Himalaya Publishers.
6. Instrumental Methods & Chemical Analysis by Galen Ewing, McGraw-Hill Publishing Company Ltd.
7. Separation Methods by M. N. Sastri, Himalaya Publishers.
8. Modern Methods of Chemical Analysis by Pecsok, Shield & Cairns.
9. Analytical Chemistry: Principles and Techniques by Larry G. Hargis, Prentice-Hall International edition.
10. Analytical Chemistry: Principles and Techniques by Larry G. Hargis, Prentice-Hall International edition.
11. Introduction to Modern Liquid Chromatography: L. R. Shyder& J. J. Kirkland, John Wiley & Sons.
12. Spectrometric Identification of Organic Compounds, RM Silverstein, FX. Webster & D. J. Kiemle.
13. Photometric and Fluorometric Methods of Analysis by F. D. Snell, John Wiley & Sons Inc.
14. Spectroscopy by Kaur H, Pragati Prakashan.
15. Instrumental Methods of Chemical Analysis by B. R. Sharma, Goel Publishing House.
16. Introduction to spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James R. Vyvyan, Cangage learning.

17. Vogel's Text Book of Quantitative Chemical Analysis, Pearson Education.

Course Outcome : After finishing this course, the student will have the ability to	
1.	Equipped with the necessary skills and knowledge to apply mathematical and statistical methods to analyze chemical data and solve problems in various fields of chemistry, including data analysis, modeling, and simulation.
2.	Develop a deep understanding of the principles, instrumentation, and applications of various chromatographic techniques used for separation, identification, and quantification of chemical compounds in complex mixtures, and be able to select and apply the appropriate technique for a given analytical problem
3.	Solid foundation in the theory, principles, and applications of UV-Visible spectroscopy for the analysis of electronic transitions and concentration of molecules in various chemical systems, and be able to apply this knowledge to solve analytical problems and interpret spectroscopic data.
4.	Understand the theory, principles, and applications of infrared spectroscopy for the analysis of molecular vibrations and structures in various chemical systems, and be able to apply this knowledge to solve analytical problems and interpret spectroscopic data.

CY105: Practical 180hr

Course Objectives:	CO1: To provide fundamental understanding of qualitative analysis of Inorganic mixture CO2: The objective is to detect and classify a set of three anions and three cations, which comprises of a rare earth element, utilizing the technique of group separation. CO3: The aim is to provide an understanding of distinct radicals through a confirmatory test. CO4: The process of producing metal salts of inorganic origin and subsequent formation of crystals. CO5:To provide fundamental understanding of the segregation process for organic ternary mixtures. CO6: To determine the type of mixture, such as solid-solid, solid-liquid, liquid-liquid, and so on, based on its characteristics. CO7: To provide an understanding of various purification methods, including the process of distillation. CO8: Separation and identification of component with their functional group test and M.P. /B.P. CO9: To verify the structure and produce the appropriate derivative. CO10: To investigate the rate constant of a chemical reaction through study. CO11: To comprehend the principles of pH measurement and potentiometric titration in analyzing the interaction between two solutions. CO12: To investigate the characteristics of both surfactants and polymers in an aqueous solution through studying their properties. CO13: To quantify the concentration of a solution using colorimetric analysis. CO14: To comprehend the conductive properties exhibited by electrolyte solutions.

	CO15: To comprehend the characteristics of phase transitions in a system consisting of three components.

Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	✓						✓		✓	✓	✓	
	CO2	✓						✓		✓	✓	✓	✓
	CO3	✓			✓			✓		✓	✓	✓	✓
	CO4	✓		✓				✓			✓	✓	✓
	CO5	✓	✓						✓	✓		✓	✓
	CO6	✓	✓		✓			✓	✓	✓		✓	✓
	CO7	✓	✓		✓			✓	✓	✓		✓	✓
	CO8	✓	✓		✓			✓	✓	✓		✓	✓
	CO9	✓		✓	✓					✓	✓	✓	✓
	CO10	✓		✓	✓		✓					✓	✓
	CO11	✓	✓		✓		✓					✓	✓
	CO12	✓	✓		✓		✓	✓		✓	✓	✓	
	CO13	✓		✓	✓					✓	✓	✓	✓
	CO14	✓	✓	✓			✓			✓	✓	✓	✓
	CO15	✓			✓			✓		✓	✓	✓	✓

Inorganic Chemistry:

Synthesis of metal complexes, double salts and estimation by gravimetry.

1.Hexa-ammine nickel (II) chloride
2.Sodium cobaltinitrite
3.Sodium trioxalato ferrate trihydrate
4.Mohr's salt (Ferrous Ammonium sulphate
5.Tetra amine cupric sulphate
6.Ammonium tetrathiocyanate diammine Chromate (Reineck's salt)

Qualitative Analysis (6 + 1 Radicals)

Six Cation, Anion variable
One rare earth element form the following:
Th, Ce, Li, Mo, Se, Te, V, Ti and Zr etc.

Organic Chemistry:

Mixture analysis:

Ternary mixture to be given. (S+S+S), Semisolids or (L+L+L). Type, determination, Separation by physical and chemical methods. (Both permitted in case of liquids)
Minimum eight mixtures
Paper Chromatography

Physical Chemistry:

1. To determine the dissociation constant of a acid pH metrically.
2. To determine the equivalent conductivity of a given electrolyte and hence examine the validity of the onsagar's theory as a law of great dilutions.
3. To investigate the reaction between $K_2S_2O_8$ and KI at two different temperatures and calculate the energy of activation for the reaction.
4. Construct phase diagram of given two componant system.
5. Find out the unknown concentration of$KMnO_4$ & $K_2Cr_2O_7$ using colorimeter

Reference books:

1. Textbook of practical inorganic chemistry by A.I. Vogel, Pearson India.
2. Advance inorganic analysis by Agarwal, Keemtilal, Pragati.
3. Qualitative Inorganic analysis by Vogel, Pearson India.
4. A text book of practical organic chemistry by A. I. Vogel, Pearson India.
5. Comprehensive Practical Organic Chemistry: Preparations and Quantitative Analysis V. K. Ahluwalia & R. Aggarwal, Universities Press.
6. A handbook of quantitative and qualitative analysis by H. T. Clarke, Cbs Publishers and Distributors Pvt Ltd.
7. Practical Physical Chemistry, Dr. M. Satish Kumar Sankalp Publication.
8. Advanced Practical Physical Chemistry by J. B. Yadav, Krishna Prakashan Media.
9. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis, Pearson.

Course Outcome : After finishing this course, the student will have the ability to	
1.	Comprehend the fundamental principles of analyzing combinations of inorganic substances.
2.	Detect the anions in a mixture through a dry test.
3.	Isolate individual anions from a mixture through a group test.
4.	Recognize each cation and validate its identity through a confirmatory test.
5.	Comprehend various techniques for producing inorganic salts.

6.	Acknowledge the importance of proper laboratory protocols.
7.	Comprehend the fundamental principles of separating organic tertiary mixtures
8.	Recognize the chemical composition and properties of a mixture.
9.	Isolate each individual component from a mixture.
10.	Recognize each component by conducting functional group tests, elemental analysis, and measuring their melting and boiling points.
11.	Refine the compounds utilizing various techniques such as distillation, crystallization, etc.
12.	Document the physical properties of each separate compound.
13.	Acknowledge the importance of following proper laboratory procedures.
14.	Comprehend the study of chemical reaction rates, known as chemical kinetics.
15.	Conduct a qualitative examination of a compound.
16.	Determine the concentration of an unknown solution by measuring its pH, utilizing a potentiometer, or using a colorimeter.
17.	Comprehend the properties and actions of surfactants and polymers.
18.	Isolate a solvent through the utilization of a phase diagram.

SEM-II

CY201: Inorganic Chemistry – II

Course Objectives:	CO1: To provide students with an understanding of the principles and applications of bioinorganic chemistry, including the structure and function of metalloproteins, metalloenzymes and their roles in biological processes. CO2: To provide students with a comprehensive understanding of the chemistry of non-transition elements, including their properties, reactions, and applications in various fields of chemistry. CO3: To provide students with an understanding of the principles and applications of organometallic compounds in inorganic chemistry, including their synthesis, characterization, and reactivity. CO4: To provide students with a comprehensive understanding of the principles and applications of metal π-complexes in coordination chemistry, including their synthesis, characterization, and reactivity.

Mapping between CO and PSO		PSO 1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO 10	PSO 11	PSO 12
	CO1	✓	✓			✓		✓		✓	✓	✓	
	CO2	✓	✓		✓		✓		✓	✓	✓	✓	
	CO3	✓	✓	✓	✓			✓			✓	✓	
	CO4	✓	✓			✓			✓		✓	✓	

Unit-I Bioinorganic chemistry **15 hr**

Introduction of bioinorganic chemistry, Classification and role of metal ions according to their action in biological system, Effect of metal ion concentration and its physiological effect, Basic principles in the biological selection of elements, Oxygen transfer and storage: Heme and non-heme proteins, Structure and function of Haemoglobin, Structure and function of myoglobin, Biochemistry of Iron storage and Transport: Ferritin,Transferrin, Electron Transfer: Cytochromes, Iron-Sulfur Proteinscopper proteins and Zinc protein (carbonic anhydrase), Bio-inorganic chemistry of vitamin B12, Bio-inorganic chemistry of chlorophyll, Metal deficiency and disease, Toxic effects ofmetals.

Unit-IIChemistryofNon-transitionElements **15 hr**

Chemistry of Non-transition Elements: General discussion on the properties of the non-transitional elements; special features of individual elements like Li and Be; preparation, properties and structure of their halides, oxides, Polymorphism of carbon, phosphorus and sulphur. Polyhedral borans, carboranes, Wade's rule, Borax and borazine molecule, Isolobal analogy, Metalloboranes and metallocarboranes compounds with M-M multiple bonds,

Synthesis, properties and structure of silicates, silicones, Phosphazenes, Oxyacids of nitrogen, phosphorus, sulphur and halogens; Interhalogen, Pseudohalides and Noble gas compounds.

Unit-III Organometallic Compounds **15 hr**

Introduction, nature of bonding in organometallic compounds of transition metals.

σ-bonded organometallic 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 and chemical properties, bonding of structure. (b) η3 allyl (or enyl) complexes: preparation, physical of chemical properties.

Unit-IV METALπ-COMPLEXES

Metal carbonyls: Introduction, Classification of metal carbonyls, Structure and bonding, Vibrational spectra studies for bonding and structure elucidation. Preparation of metal carbonyls by (1) Direct synthesis and (2) From metal compounds; Preparation, properties and structure of $Ni(CO)_4$, $Fe_2(CO)_9$ and $Co_2(CO)_8$, 18-electron rule and EAN of metal carbonyls. Metal Nitrosyls: Introduction, Coordination compounds of metal nitrosyls, Preparation and properties of nitrosyl compounds like nitrosyl halides, nitrosyl cyanides, hydroxides and nitrosyl aquo compounds, Complex of NO^+ iron, EAN and structures of nitrosyls.

Reference Books:

1. Bioinorganic Chemistry by R. W. Hay, Ellis Harwood.
2. Inorganic Biochemistry-An introduction, J. A. Cowan, VCH Publication.
3. Elements of Bioinorganic Chemistry, G. N. Mukherjee and A. Das, Dhuri& Sons.
4. Concise Inorganic Chemistry by J.D. Lee, Chapman & Hall.
5. Descriptive Inorganic Chemistry by G. R. Canham, T. Overton, W. H. Freeman.
6. Principles of Descriptive Inorganic Chemistry, G. Wulfsberg, University Science Books.
7. Organometallic Chemistry by R. C. Mehrotra, New Age International.
8. The Organometallic Chemistry of the Transition Metals, R. H. Crabtree, John Wiley & Sons.
9. Organometallic Chemistry and Catalysis by D. Astruc, Springer Science & Business Media.
10. Introduction to Metal π-Complex Chemistry by M. Tsutsu.

Course Outcome : After finishing this course, the student will have a	
1.	Comprehensive understanding of the principles and applications of bioinorganic chemistry, enabling them to design and develop novel metal-based therapeutics, understand the mechanisms of metalloenzyme catalysis, and analyze metalloprotein structures and functions using spectroscopic and computational techniques.
2.	Comprehensive understanding of the chemistry of non-transition elements, enabling them to analyze and interpret their properties, reactions, and applications in various fields of chemistry, including materials science, environmental chemistry, and biochemistry. They will also be able to design and develop new materials and processes that utilize non-transition elements.
3.	Understanding of the principles and applications of organometallic compounds in inorganic chemistry, enabling them to analyze and interpret their synthesis, characterization, and reactivity, and apply this knowledge to design and develop new organometallic compounds with tailored properties for various applications in catalysis & materials science.
4.	Comprehensive understanding of the principles and applications of metal π-complexes in coordination chemistry, enabling them to analyze and interpret their synthesis, characterization, and reactivity, and apply this knowledge to design and develop new metal π-complexes with tailored properties for various applications in catalysis, materials science, and bioinorganic chemistry. They will also be able to analyze and interpret metal π-complexes using spectroscopic and computational techniques.

CY201: Organic Chemistry – II

Course Objectives:	CO1: To provide students with a deep understanding of the concept of aromaticity in organic chemistry, including its theoretical basis, properties, and applications. CO2: To provide students with an understanding of the latest advances in reagents and name reactions in organic chemistry, including their design, development, and applications in various synthetic transformations. CO3: To provide students with an understanding of the fundamental principles, concepts, and applications of photochemistry, including the electronic and molecular processes involved in light-induced reactions. CO4: To provide students with an understanding of the principles and applications of organic chemistry in the context of industrial processes, including the design, development, and scale-up of organic reactions for the production of chemicals, materials, and pharmaceuticals.

Mapping between CO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	✓	✓			✓		✓		✓	✓	✓	

and PSO	CO2	✓	✓		✓		✓		✓	✓	✓	✓	
	CO3	✓	✓	✓	✓			✓			✓	✓	
	CO4	✓	✓			✓			✓		✓	✓	

Unit-I AROMATICITY **15 hr**

Concept of aromaticity, non-aromaticity and anti-aromaticity, Huckel's rule and its applications to simple and non-benzenoid aromatic compounds, cyclopentadiene, azulene, tropolone system, annulenes, hetero annulenes, and fullerenes (C60).

Unit-IIAdvancesinreagentsandnamereactions-II: **15 hr**

Reagents: Reagents in organic synthesis [reduction]: General reduction protocols, applications of the following in organic reductions, $LiAlH_4$, $NaBH_4$, Luche reduction, $Al(O\text{-}iPr)_3$, ; Chemistry of PTC, DCC, Baker's Yeast.

Named reactions: Vilsmer-Haack, Suzuki coupling, Stille coupling, Prins reaction, Barton reaction, Robinson annulations.

Unit-III Photo Chemistry **15 hr**

Fundamental of photochemistry, Principles of photo chemistry, Singlet and triplet states, Properties and nomenclature of excited states. Physical properties of excited molecules as explained by improved Jablonskii diagram, Photochemistry of carbonyl compounds. Photochemistry of olefins, Recent reactions in photochemistry.

Unit-IVOrganicChemistryinindustry **15 hr**

Introduction, Process Chemistry versus Research Chemistry

Pharmaceutical Industry: Drug Discovery, Drug development, Preclinical and clinical testing, Medicine, Future Problems and Opportunities

Agrochemical Industry: Classification, Biodegradable and Persistent Pesticides, Toxicity, Chemical Classification of Pesticides-Herbicides and Insecticides

Reference Books:

1. Organic Chemistry by G. Marc. Loudon, Oxford University.
2. Organic Chemistry by J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press.
3. Advanced Organic Chemistry (4thedition) by Jerry March
4. Organic Chemistry by Morrission and Boyd, Prentice Hall Pvt.Ltd.
5. A Text Book of Organic Chemistry by R. K. Bansal, New Age International Ltd.
6. Modern Molecular Photochemistry by by Nicholas J. Turro, University Science Books.
7. Pharmaceutical Process development: Current Chemical and Engineering Challenges by J. Blacker and M. T. Williams.
8. Advances in Photochemistryby James N. Pitts, wiley.
9. Fine Chemicals: The Industry and Its Business by P. Pollak

10. Organic Reaction Mechanisms by V. K. Ahluwalia, Rakesh K. Parashar, Narosa.

Course Outcome : After finishing this course, the student will have a	
1.	Understanding of the concept of aromaticity in organic chemistry, enabling them to analyze and interpret the properties and reactivity of aromatic compounds, and apply this knowledge to design and develop new aromatic compounds with tailored properties for various applications in materials science, drug discovery, and organic synthesis.
2.	Understanding of the latest advances in reagents and name reactions in organic chemistry, enabling them to analyze and interpret the design, development, and applications of reagents and name reactions, and apply this knowledge to design and develop new synthetic strategies for various applications in organic synthesis, drug discovery, and materials science. They will also be able to critically evaluate the advantages and limitations of different reagents and name reactions.
3.	Understanding of the principles and concepts of photochemistry, to analyze and interpret the photochemical reactions of organic and inorganic compounds, and apply this knowledge to design and develop new photochemical reactions for various applications in materials science, drug discovery, and environmental remediation.
4.	Able to apply their knowledge of organic chemistry to design and optimize synthetic routes for the production of pharmaceuticals and agrochemicals, and to evaluate the economic and environmental impact of these processes.

CY203: Physical Chemistry – II

Course Objectives:	CO1: To provide students with a comprehensive understanding of the principles and techniques used in the statistical analysis of thermodynamic systems. CO2: to equip students with a thorough understanding of the principles, processes, and applications of electrochemical reactions and systems. CO3: to provide students with a comprehensive understanding of the fundamental properties, behavior, and characteristics of solids and liquids. CO4: to enable students to deepen their understanding of the principles, theories, and mathematical models governing chemical reactions and their rates.

Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	✓	✓			✓		✓		✓	✓	✓	
	CO2	✓	✓		✓		✓		✓	✓	✓	✓	
	CO3	✓	✓	✓	✓			✓			✓	✓	
	CO4	✓	✓			✓			✓		✓	✓	

Unit-I Statistical Thermodynamics **15 hr**

Basics of Statistical thermodynamics (Assembly, Canonical ensemble, occupation number statistical weight factor, probability), Thermodynamic probability, Probability and entropy, Maxwell- Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Lagrange's methods of multipliers, Partition function, Thermodynamic properties in term of partition functions: (i) Internal energy (ii) Heat Capacity (iii) Third law of thermodynamics (iv) Helmholtz free energy (v) Enthalpy (vi) Gibb's free energy (vii) Chemical potential (viii) Equilibrium constant. Molecular partition functions for an ideal gas, Derivation for Translational, Rotational and Vibrational partition functions, Numericals.

Unit-II Electrochemistry **15 hr**

Nernst equation, Standard electrode potentials: The electrochemical series, Electromotive force of galvanic cells, Concentration cells, LJP (Liquid Junction Potential),

Applications of EMF measurment: Determination of transport numbers, Determination of pH, Determination of solubility product constants.

Debye- Huckel theory of activity coefficients of strong electrolytes, Irreversible electrode processes: overvolatage and its inhibition.

Unit-III Properties of Solids and Liquids **15 hr**

Solid State, Physical Methods of characterizing solids; Solid and crystalline state: Crystalline solid, X-ray diffraction method for crystal structure determination. The types of matter, classification of solids, close packing of atoms; Voids in closest packings; Defects and non-stoichiometry, Microporous and Mesoporous solids, Radius ratio rule, Structure of ionic Crystals;

Ionic Crystals with stoichiometry MX, Ionic Crystals with

Stoichiometry MX2

Properties of Liquids:

Viscosity properties: Introduction- concept of viscosity, factors influencingviscosity.

Newtonian system: Newtonian law of flow. Kinematic viscosity, temperature dependence and theory of viscosity. Non- Newtonian system: Plastic flow, Pseudoplastic flow and dilatants flow

Unit-IV ChemicalKinetics-II **15 hr**

Michaellis menton equation, Theories of unimolecular gaseous reactions: Lindmann theory

Kinetics of complex reactions: Opposing or reversible reactions, Kinetics of consecutive reactions, Kinetics of chain reactions and Kinetics of brached chain reactions

Reference Books:

1. Physical Chemistry, P. W. Atkins, ELBS.
2. Modern Electrochemistry, J.O.M. Bookris and A. K. N.Reddy, Springer.

3. Introduction to Electrochemistry by Glasstone, Affiliated East West Press Pvt Ltd.
4. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing co.
5. Chemical sciences by Dr. Hemant Kulshrestra & Dr. Ajay Taneja, Upakar Publication.
6. Basic Chemical Kinetics by G. L. Agrawal, Tata-McGraw-Hill.
7. Chemical Kinetics by Ira N. Levin, Prentice Hall.
8. Chemical Kinetics by P.W. Atkins, ELBS.

Course Outcome : After finishing this course, the student will have a (an)	
1.	Able to apply statistical methods to analyze and interpret the behavior of thermodynamic systems, and effectively utilize statistical thermodynamics principles in solving complex problems.
2.	Able to analyze and predict electrochemical phenomena, interpret experimental data, and apply electrochemical principles to solve practical problems in various fields such as energy storage, corrosion prevention, and chemical synthesis.
3.	able to analyze and interpret the properties of solids and liquids, apply theoretical models to explain their behavior, and utilize this knowledge to solve problems related to materials science, phase transitions, and physical properties of substances.
4.	Able to analyze and predict reaction rates, design experiments to study reaction kinetics, interpret experimental data using kinetic models, and apply this knowledge to optimize reaction conditions and develop efficient chemical processes.

CY203: Analytical Chemistry – II

Course Objectives:	CO1: To provide students with a comprehensive understanding of the principles, techniques, and applications of classical analytical methods used in chemical analysis. CO2: To provide students with a comprehensive understanding of the principles, techniques, and applications of mass spectrometry in the analysis of molecular structures and their masses. CO3: To equip students with a comprehensive understanding of the principles, techniques, and applications of nuclear magnetic resonance spectroscopy in the analysis of molecular structures and their chemical environments. CO4: To provide students with a comprehensive understanding of the principles, techniques, and applications of thermal analysis methods in characterizing materials and studying their thermal behavior.

Mapping between CO		PSO 1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO 10	PSO 11	PSO 12
	CO1	✓	✓			✓		✓		✓	✓	✓	

and PSO	CO2	✓	✓		✓		✓		✓	✓	✓	✓	
	CO3	✓	✓	✓	✓			✓			✓	✓	
	CO4	✓	✓			✓			✓		✓	✓	

Unit-I CLASSICAL METHODS OF ANALYSIS 15hr

Stoichiometric calculations and numerical: weight, mole, molarity, ppm, dilution, standardization and back titrations.

Gravimetric methods of analysis, Factors affecting good precipitates, Co-precipitation of precipitates, Applications of gravimetric methods. Factors affecting precipitation titration, titrimetric methods and types of analysis based on volume.

Precipitation titrations: Principle, Types of titration, Indicators, Volumetric curves and calculations.

Complexometry: Complexation reactions and titrations. Formation of complexes, Complexation equilibria, calculating alpha value of complexes, Complexometric titrations, Complex forming agent, Step-wise stability constants, EDTA as complexing agent, Complexometric titration curves, Indicators for complexometric titrations. Masking agent, other complexometric methods. Standard EDTA solutions, some practical considerations during EDTA titrations. Titration of mixtures (Mg^{2+}& Ca^{2+}; Pb^{2+}& Ca^{2+}; Mn^{2+}& Mg^{2+}), Selectivity, Masking and demasking agents. Metal ion indicators: General properties, Theory of the use of metal ion indicators, Numericals.

Unit-II MOLECULAR MASS SPECTROSCOPY 15 hr

Molecular mass spectroscopy: Principle, Instrumentation of mass spectrometers, Ionisation, Fragmentation and dispersion of ions, Mass spectrum, Electron Impact and chemical ionisation. Sample handling, Molecular ion and its intensity, The Base peak, Parent peak, Resolution, Nitrogen rule, Ring rule, Fragmentation pattern and Mass spectra of classes of Organic Compounds, Use of mass spectra to elucidate structure of organic compounds

Unit-III NMR SPECTROSCOPY 15 hr

1H NMR spectroscopy: Theory of NMR, Principle, Larmor Frequency and precession, NMR instrumentation, Chemical shift, NMR spectra, Reference materials, Solvents, Sampling. Equivalent and non-equivalent protons, Chemical Shift, Shielding and deshielding of protons, Inductive effect, Magnetic anisotropy, Spin-Spin coupling (first order analysis), Coupling constant (J value), More complex spin-spin systems, Non-first order spectra, Structure elucidation from NMR spectra, Study of NMR Spectra of some illustrative compounds.

13C NMR SPECTROMETRY: Introduction, Comparison of 13C and 1H NMR spectroscopy, Chemical classes: Aliphatic chains, alkenes and alkynes; Chemical Shifts, 13C-1H Spin Coupling (J values).

Unit-IV THERMAL METHODS 15hr

Thermogravimetry: Principle, Instruments for TGA & DTG, Calibration of temperature scale, Factors affecting TGA results, Applications, Evolved gas detection and analysis, Differential thermal analysis (DTA), Factors affecting DTA results, Applications Differential scanning

calorimetric (DSC) analysis, Instruments, Reference materials, Diluents, Thermometric titration (TT), Advantages, Instrument, Direct injection (Numericals).

Reference Books:

1. Instrumental Methods & Chemical Analysis by Galen Ewing, McGraw-Hill Publishing Company Ltd.
2. Analytical Chemistry by Gary D. Christian, John Wiley and sons. Inc.
3. Principles of Instrumental Analysis by Skoog, Holler, Nieman, Harcourt College Publishers.
4. Quantitative Chemical Analysis by Daniel C. Harris, Freeman & Co. New York.
5. Vogel's Text Book of Quantitative Chemical Analysis, Pearson Education.
6. Basic Chemical Kinetics by G. L. Agrawal, Tata-McGraw-Hill.
7. Instrumental Methods of Chemical Analysis by G. W. Ewing, McGraw-Hill.
8. Modern Methods of Chemical Analysis by Pecsok, Shield & Cairns, John Wiley.
9. Introduction to Instrumental Analysis by R. D. Braun, McGraw-Hill Book Company.
10. Analytical Chemistry: Principles and Techniques by Larry G. Hargis, Prentice-Hall International edition.
11. Instrumental Methods of Chemical Analysis by B. R. Sharma, Goel Publishing House.
12. Introduction to spectroscopy by Donald L. Pavia, Gary M. Lampman, George S. Kriz, and James R. Vyvyan, Cangage learning.
13. Spectrometric Identification of Organic Compounds by M. Silverstein, F. X. Webster & D. J. Kiemle, Wiley.
14. Spectroscopy by Kaur H, Pragati Prakashan.

Course Outcome : After finishing this course, the student will have a (An)	
1.	Apply classical analytical methods, such as gravimetry and titration, to accurately determine the composition and concentration of chemical species in a variety of samples, and effectively utilize these methods to solve complex analytical problems in various fields such as environmental monitoring, pharmaceutical analysis, and food safety.
2.	Interpret mass spectra, identify unknown compounds, analyze molecular structures, and utilize mass spectrometry techniques to solve complex problems in fields such as organic chemistry, biochemistry, and forensic science.
3.	able to interpret NMR spectra, determine the structures and connectivity of organic molecules, analyze chemical shifts and coupling patterns, and utilize NMR spectroscopy to solve complex problems in fields such as organic chemistry, medicinal chemistry, and materials science.

4.	Able to apply thermal analysis techniques, such as differential scanning calorimetry and thermogravimetric analysis, to investigate phase transitions, thermal stability, decomposition reactions, and material properties, and utilize this knowledge to solve complex problems in areas such as materials science, pharmaceuticals, and polymers.

CY205: Practical 180hr

Course Objectives:	CO1: To provide fundamental understanding essential for conducting analysis of alloys. CO2: To Acquire knowledge about various categories of complexometric titrations. CO3: To Gain proficiency in comprehending and computing the purity percentage of salts. CO4: To Perform measurements of physical constants and verify product authenticity. CO5: To Grasp the concepts and techniques involved in both quantitative and qualitative determination of individual radicals. CO6: Comprehend the characteristics of reactions and the establishment of optimal reaction conditions through mechanistic understanding. CO7: Gain proficiency in calculating moles and mole ratios for each reaction. CO8: Perform the isolation of products from individual reaction steps and purify them using crystallization techniques. CO9: Determine physical constants and confirm the identity of products. CO10: Understand the concepts and methods for quantitatively estimating and determining the concentration of each component. CO11: Gain knowledge on studying the reaction rate using conductometry. CO12: Perform concentration determination of solutions using colorimetry. CO13: Comprehend the conductive properties of electrolyte solutions. • Explore the partitioning behavior of components between two phases.

Mapping between CO and PSO		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
	CO1	✓	✓			✓		✓		✓	✓	✓	
	CO2	✓	✓		✓		✓		✓	✓	✓	✓	
	CO3	✓	✓	✓	✓			✓			✓	✓	
	CO4	✓	✓			✓			✓		✓	✓	

Inorganic Chemistry:

Quantitative Analysis

1. Analysis of solder and type metal (Alloy Analysis)

2. Determine the amount of Ca as $CaC_2O_4.H_2O$ or as $CaCO_3$, in limestone
3. Estimation of Cu^{+2} as CUSCN.
4. Estimation of Iron in iron ore.
5. Estimation of available chlorine in bleaching powder.
6. Estimation of Ca^{+2} and Pb^{+2} in Admixture.
7. Determine the amount of Fe^{+3} and Cr^{+3} Present in given admixture.
8. Determine the percentage purity of the given sample of manganese salt.
9. Estimation of aluminum by back titration.

Organic Chemistry:

Preparation of organic compounds:
1. Nitration
2. Bromination
3. Acylation
4. Reduction
5. Oxidation
6. Condensation reaction
7. Diazotization reaction
8. Friedel-Craft's reaction
9. Cannizzaro reaction
10 .Aldol condensation

Quantitative Estimations:
1. Estimation of ester + acid
2. Estimation of formaldehyde
3. Estimation of glycine
4. Estimation of amide + acid

Physical Chemistry:
1. Calculate the concentration of unknown solution by potentiometer.
2. Determination of the Critical micelle concentrations (CMC) and surface active parameters of surfactant by surface tension method.
3. Find out molecular weight of given polymer using viscometer method.
4. Calculate solubility product of AgCl.
5. Stalagnometer practical.
6. pH (Borax and KI).

Reference books:

1. Advance inorganic analysis by Agarwal, Keemtilal, Pragati.
2. Qualitative Inorganic analysis by Vogel, Pearson India.
3. Inorganic practical by Chatwal and Anand, Himalaya publication house.

4. Comprehensive Practical Organic Chemistry: Preparations and Quantitative Analysis V. K. Ahluwalia & R. Aggarwal, Universities Press.
5. A text book of practical organic chemistry by A. I. Vogel, Pearson India.
6. A handbook of quantitative and qualitative analysis by H. T. Clarke, Cbs Publishers and Distributors Pvt Ltd.
7. An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal, New Central Book Agency.
8. Advanced Practical Physical Chemistry by J. B. Yadav, Krishna Prakashan Media.
9. Quantitative Chemical Analysis by Mendham, J. A. I. Vogel's, Pearson.
10. Practical Physical Chemistry, Dr. M. Satish Kumar Sankalp Publication.

Course Outcome : After finishing this course, the student will have an able to	
1.	Acquire knowledge on alloy and ore analysis, as well as the calculation of molarity and mole ratios.
2.	Familiarize oneself with both gravimetric and volumetric methods for determining copper and zinc.
3.	Gain proficiency in determining the available chlorine content in bleaching powder.
4.	Develop skills in determining the presence of calcium, lead, iron, and chromium in admixtures.
5.	Recognize the importance of adhering to proper laboratory practices and protocols.
6.	Acquire fundamental knowledge required to conduct reactions, comprehend reaction characteristics, and perform mole and mole ratio calculations.
7.	Establish reaction mechanisms and monitor reactions under specific conditions.
8.	Perform necessary procedures after the completion of reactions, including work-up and purification.
9.	Confirm the identity and characteristics of the product through reference materials.
10.	Recognize and value the importance of maintaining good laboratory practices.
11.	Apply pH, potentiometer, and colorimeter methods to calculate the concentration of unknown solutions.
12.	Gain an understanding of the characteristics of surfactants and polymers.
13.	Explore the impact of concentration on the solubility product.