# Indrashil University


## Department of Chemistry
## School of Science

## M.Sc. 2026-2028 Sem I-II

## Organic Chemistry

## Course Profile

## Academic Year 2026-2027

## Course Structure M.Sc. Chemistry Semesters I to II

| SEMESTER: I | MINIMUM SEMESTER CREDIT REQUIRED: 20<br>CUMULATIVE SEMESTER CREDITS REQUIRED: 20 | | |
|---|---|---|---|
| **SUBJECT NO.** | **SUBJECT NAME** | **L-T-P** | **CREDITS** |
| CH4 101 | ORGANIC CHEMISTRY – I: LOGICS IN ORGANIC REACTION AND MECHANISM | 3-0-0 | 3 |
| CH4 102 | INORGANIC CHEMISTRY – I: COORDINATION CHEMISTRY & MAGNETIC MATERIALS | 3-0-0 | 3 |
| CH4 103 | PHYSICAL CHEMISTRY – I: MOLECULAR THERMODYNAMICS AND SOLID-STATE PROPERTIES | 3-0-0 | 3 |
| CH4 104 | ANALYTICAL CHEMISTRY – I: INSTRUMENTAL METHODS OF ANALYSIS | 3-0-0 | 3 |
| CH4 105 | QUANTUM MECHANICS FOR CHEMISTS | 3-0-0 | 3 |
| CH4 106 | BASIC ORGANIC CHEMISTRY LABORATORY | 0-0-8 | 4 |
| CH4 107 | INORGANIC CHEMISTRY LABORATORY | 0-0-8 | 4 |
| **Total** | | **15L-16P** | **23** |

| SEMESTER: II | MINIMUM SEMESTER CREDIT REQUIRED: 43 CUMULATIVE SEMESTER CREDITS REQUIRED: 23 | | |
|---|---|---|---|
| **SUBJECT CODES** | **SUBJECT NAME** | **L-T-P** | **CREDITS** |
| CH4 201 | ORGANIC CHEMISTRY – II: REACTIONS, REAGENTS, AND REARRANGEMENTS | 3-0-0 | 3 |
| CH4 202 | INORGANIC CHEMISTRY – II: MAIN GROUP AND ORGANOMETALLIC COMPOUNDS | 3-0-0 | 3 |
| CH4 203 | PHYSICAL CHEMISTRY – II: SURFACE AND INTERFACIAL CHEMISTRY | 3-0-0 | 3 |
| CH4 204 | BIOORGANIC CHEMISTRY: | 3-0-0 | 3 |
| CH4 205 | SPECTROSCOPY – I: MOLECULAR STRUCTURE DETERMINATION | 3-0-0 | 3 |
| CH4 206 | ANALYTICAL TECHNIQUES LABORATORY | 0-0-8 | 4 |
| CH4 207 | PHYSICAL CHEMISTRY LABORATORY | 0-0-8 | 4 |
| **Total** | | **15L-16P** | **23** |

**SEMESTER I**
**DETAILED SYLLABUS**

## CH4 101: ORGANIC CHEMISTRY-I: LOGICS IN ORGANIC REACTION AND MECHANISM (L-T-P-C: 3-0-0-3)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** I |
| **Course code:** CH4 101 | **Course name:** ORGANIC CHEMISTRY-I: LOGICS IN ORGANIC REACTION AND MECHANISM |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- Understand and apply the fundamental principles of structure and reactivity
- Analyze and compare reaction mechanisms
- Develop proficiency in stereochemical concepts and conformational analysis

**Course Outcome:** At the end of this course, the students will be able to

**CO 1:** Familiarize with types of reactions, their mechanisms, and reactivity of organic reactive intermediates

**CO 2:** Understand the Hammett equation, Hammond's postulate, Curtin-Hammett principle, and HSAB Principle.

**CO 3:** Get an idea about SNAr, SRN1, and benzyne mechanism, the NGP, and anchimeric assistance.

**CO 4:** Be able to understand Classical and non-classical carbocations. Aromatic electrophilic substitution reactions, arenium ion mechanism, the ortho/para ratio, ipso attack,

**CO 5:** Knowledge of Basic principles of Stereochemistry, chirality, Prochiral relationship, and optical activity in biphenyls, spiranes, allenes, and helical structures. Stereochemistry of compounds containing Nitrogen, Sulphur, and Phosphorus.

### Syllabus

| Units | Contents | Hours |
|---|---|---|
| **Unit I:** Structure and Reactivity | Structure and Reactivity: Chemical bonding; Bond Polarity and Dipole Moment, Resonance and, Various Electronic Delocalization and its Role in Stability; Steric Effects<br>Aromaticity; Hard and Soft Acids and Bases (HSAB Principle); Frontier Molecular Orbital Theory (HOMO-LUMO Concepts); Thermodynamic vs. Kinetic Control; Hammond's Postulates; Reactive Intermediates:<br>Carbocations, Carbanions, Free Radicals, Carbenes and Nitrenes; Transition State Theory and Curtin–Hammett Principle; Energy profiles and reaction coordinate, Energy profiles and reaction; Coordinate Diagrams for Catalysed and Un-catalysed Reactions; Effect of Solvent Polarity; Substituent Effects on Reactivity; Molecular Strain and reactivity; Ring Strain and Bredt's Rule; Baeyer Strain Theory | **15** |
| **Unit II:** Organic Reaction Mechanism | **Organic Reaction Mechanism:** Bond cleavage: homolytic vs. heterolytic cleavage<br>**Types of Reactions and their mechanism:** Nucleophilic Substitution Reactions**:** $SN_1$ and $SN_2$ mechanisms; Stereoelectronic Control): kinetics, stereochemistry, and energy diagrams; Neighboring group participation (NGP); Ambident nucleophiles<br>**Elimination Reactions:** $E_1$, $E_2$, and E1cb mechanisms; Hofmann vs. Zaitsev elimination; Base strength and solvent effects; Stereoelectronic requirements<br>**Addition Reactions:** Electrophilic, nucleophilic, and radical additions; Markovnikov vs. anti-Markovnikov additions; Stereochemistry in *syn/anti* additions; Addition to carbon–heteroatom multiple bonds (e.g., C=O, C=N)<br>**Aromatic Substitution Mechanisms:** Electrophilic aromatic substitution (EAS); Nucleophilic aromatic substitution (NAS): SNAr, benzyne mechanism | **15** |

| | | |
|---|---|---|
| **Unit III:** Stereochemistry and Conformational Analysis | Stereochemistry: Isomerism; Constitutional vs. Stereoisomerism; Types of Stereoisomers: Enantiomers, Diastereomers, Meso Compounds; Optical Activity: Chirality, Specific Rotation, Optical Purity; Absolute and Relative Configuration: CIP Rule for R/S Nomenclature; Stereoselective vs. Stereospecific Reactions Projection Formulas and Interconversion; Define Fischer, Sawhorse, Newman, Representations; Interconversion of different projections; Stereochemical assignment; Conformational Analysis of Acyclic and Cyclic Systems; Conformations of ethane, butane: eclipsed, staggered, gauche, anti; Cyclohexane; conformations: chair, boat, twist-boat; conformational preference; Energy barriers and conformational equilibrium; Effect of substituents on conformational stability | **15** |

## CO-PO Mapping

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO6 |
|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | **2** | **-** | **-** | **-** |
| **CO2** | **3** | **3** | **2** | **2** | **-** | **-** | **1** |
| **CO3** | **3** | **3** | **2** | **2** | **1** | **-** | **-** |
| **CO4** | **3** | **2** | **2** | **1** | **1** | **-** | **-** |
| **CO5** | **3** | **3** | **2** | **2** | **1** | **-** | **1** |

## CO-PO Mapping Justification

| CO | Justification |
|---|---|
| **CO 1** | Understanding structure, bonding, electronic effects, aromaticity, and molecular orbital concepts strengthens advanced chemical knowledge (PO1), analytical thinking and problem-solving skills (PO2), supports interpretation of molecular behavior (PO3), and provides a foundation for research-oriented studies (PO4). |
| **CO 2** | Evaluation of reaction energetics, intermediates, and mechanistic pathways develops critical thinking and advanced knowledge (PO1), enhances problem-solving abilities (PO2), strengthens analytical skills (PO3), supports research aptitude (PO4), and promotes scientific integrity in data interpretation (PO7). |
| **CO 3** | Mechanistic analysis enhances conceptual understanding (PO1), develops logical reasoning and problem-solving abilities (PO2), supports analytical expertise (PO3), contributes to research and industrial applications (PO4), and improves scientific communication skills (PO5). |
| **CO 4** | Application of stereochemical concepts strengthens subject knowledge (PO1), develops analytical and problem-solving skills (PO2), supports structural characterization (PO3), provides a basis for advanced synthesis and research (PO4), and enhances scientific communication through stereochemical representations (PO5). |
| **CO 5** | Prediction of stereochemical and conformational behavior develops advanced disciplinary knowledge (PO1), strengthens problem-solving capabilities (PO2), enhances analytical expertise (PO3), supports research-oriented learning (PO4), improves communication of scientific findings (PO5), and encourages responsible interpretation of scientific results (PO7). |

**Reading references:**


1. E. L. Eliel. *Stereochemistry of Carbon Compounds*. TATA McGraw-Hill Publishing Company Ltd., New Delhi. 1962, 1st Ed.
2. D. Nasipuri. *Stereochemistry of Organic Compounds*. New Age International (P) Ltd., Publishers, New Delhi. 1994, 2nd Ed.
3. P. S. Kalsi. *Stereochemistry: Conformation and Mechanism*. New Age International (P) Ltd., Publishers, New Delhi. 2019, 10th Ed.
4. J. March. *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*. Wiley-Interscience, A John Wiley & Sons, Inc., New York. 2006, 6th Ed.
5. P. Sykes. *A Guidebook to Reaction Mechanisms in Organic Chemistry*. Longman Scientific & Technical, Essex. 1986, 6th Ed.
6. S. M. Mukherji; S. P. Singh. *Reaction Mechanism in Organic Chemistry*. Macmillan India Ltd., New Delhi. 1976, Revised Ed.
7. L. G. Wade Jr. *Organic Chemistry*. Pearson Education, New Delhi. 2011, 8th Ed.
8. F. A. Carey; R. J. Sundberg. *Advanced Organic Chemistry, Part A and Part B: Structure and Mechanisms*. Springer, New York. 2007, 5th Ed.
9. J. Clayden; N. Greeves; S. Warren; P. Wothers. *Organic Chemistry*. Oxford University Press, Oxford. 2014, 2nd Ed.

## CH4 102: INORGANIC CHEMISTRY-I: COORDINATION CHEMISTRY & MAGNETIC MATERIALS (L-T-P-C: 3-0-0-3)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** I |
| **Course code:** CH4 102 | **Course name:** INORGANIC CHEMISTRY-I: COORDINATION CHEMISTRY & MAGNETIC MATERIALS |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- Learn about different types of isomers, coordination polyhedra and molecular symmetry.
- Understand redox reactions, the Nernst equation
- Comprehend inorganic reaction mechanisms
- Have a concept of magnetic materials, calculation of magnetic moment

**Course Learning Outcomes:** At the end of this course, students will be able to
**CO 1:** Identify different coordination isomers.
**CO 2:** Compare different strengths of acids and bases.
**CO 3:** Classify the molecular symmetry by using the group theory concept.
**CO 4:** Develop the concept of a redox reaction, the Nernst equation, and Inorganic reaction mechanisms.

Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I:** Isomerism | **Principles of Inorganic Chemistry**: Isomerism, Structural and stereoisomerism of tetrahedral, square planar and octahedral complexes, facial and meridional isomers, methods to distinguish cis and trans isomers, the concept of ligand- ambidentate, chelating, innocent, non-innocent and bridging ligand, flexidentate behavior of polydentate ligand, Chelate complex, EDTA. | **15** |
| **UNIT-II** Molecular Symmetry, Structure, and Reactivity | ***Symmetry and Group Theory***: Definitions and theorems of group theory, subgroups, Classes Molecular symmetry and symmetry groups – symmetry elements and operations. Symmetry planes, reflections, inversion centre, proper/ improper axes of rotation, products of symmetry operations, equivalent symmetry elements and atoms, symmetry elements and optical isomerism, symmetry point groups, classes of symmetry operations.<br>**Inorganic Reaction Mechanisms:** Substitution reactions - Dissociative and associative interchange - trans-effect: polarization theory, pi-complexing theory, cis effect, and -redox reactions, concept of oxidant and reductant, disproportionation and comproportionation reaction, std electrode potential and electrochemical series, formulation of Nernst equation, calculation of k value for given inorganic reaction, Latimer diagram, redox indicator, Z-R solutions. | **15** |
| **III** Magnetism and Inorganic Compounds | **Magnetic Properties:** Classification of magnetic materials; Cooperative phenomena – Diamagnetism, Paramagnetism, ferro, anti-ferro and ferrimagnetism, Magnetic permeability, Magnetic moment, quenching of magnetic moment: 1. By super exchange process, 2) by metal-metal direct bond formation (compounds of Cr and Cu), Curie equation, effect of orbital contribution to spin magnetic moment in oct. and tet-field for $d^n$ ion and calculation of effective magnetic moment. | **15** |

### CO-PO Mapping Table

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **1** | **2** | **-** | **-** |

| | | | | | |
|---|---|---|---|---|---|
| **CO 2** | **3** | **2** | **2** | **-** | **-** |
| **CO 3** | **3** | **2** | **3** | **1** | **-** |
| **CO 4** | **3** | **3** | **3** | **1** | **-** |
| **Average** | **3** | **2.00** | **2.50** | **1** | **-** |

**Correlation levels:**
**1 - Low, 2 - Moderate, 3 - High**

## Justification for CO-PO Mapping

| COs | Justification |
|---|---|
| **CO 1** | Develops fundamental knowledge of coordination chemistry and isomerism while strengthening analytical skills for identifying coordination compounds (PO1, PO2, PO3). |
| **CO 2** | Enhances understanding of acid–base behavior and chemical reactivity, promoting analytical reasoning and problem-solving skills (PO1, PO2, PO3). |
| **CO 3** | Develops knowledge of molecular symmetry and group theory with applications in structural analysis, fostering analytical thinking and research orientation (PO1, PO3, PO4) |
| **CO 4** | Strengthens understanding of redox chemistry, the Nernst equation, inorganic reaction mechanisms, and magnetic properties while developing quantitative analysis and scientific problem-solving abilities (PO1, PO2, PO3, PO4). |

**Reading references:**


1. P. Atkins; T. Overton; J. Rourke; M. Weller; F. Armstrong. *Shriver and Atkins' Inorganic Chemistry*. W. H. Freeman and Company, New York. 2009, 5th Ed.
   or
   D. F. Shriver; P. W. Atkins. *Inorganic Chemistry*. W. H. Freeman and Company, New York. 1999, 3rd Ed.
2. C. Housecroft; A. G. Sharpe. *Inorganic Chemistry*. Prentice Hall/Pearson Education, Harlow. 2008, 3rd Ed.
   or
   C. Housecroft; A. G. Sharpe. *Inorganic Chemistry*. Prentice Hall/Pearson Education, Harlow. 2012, 4th Ed.
3. F. A. Cotton; G. Wilkinson. *Advanced Inorganic Chemistry*. John Wiley & Sons, New York. 1988, 5th Ed.
   or
   F. A. Cotton; C. A. Murillo; M. Bochmann; R. N. Grimes. *Advanced Inorganic Chemistry*. John Wiley & Sons, New York. 1999, 6th Ed.
4. J. E. Huheey; E. A. Keiter; R. L. Keiter. *Inorganic Chemistry: Principles of Structure and Reactivity*. Prentice Hall, New Jersey. 1997, 4th Ed.
5. G. L. Miessler; D. A. Tarr. *Inorganic Chemistry*. Pearson Education, New Delhi. 2004, 3rd Ed.
6. G. Wulfsberg. *Inorganic Chemistry*. University Science Books, Sausalito. 2000, 2nd Ed.

## CH4 103: PHYSICAL CHEMISTRY-I: MOLECULAR THERMODYNAMICS AND SOLID-STATE PROPERTIES (L-T-P-C: 3-0-0-3)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** I |
| **Course code:** CH4 103 | **Course name:** PHYSICAL CHEMISTRY-I: MOLECULAR THERMODYNAMICS AND SOLID-STATE PROPERTIES |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objective:** This course aims to provide advanced understanding of statistical thermodynamics, chemical kinetics, and solid-state chemistry. Students will learn the principles of partition functions, statistical distributions, reaction kinetics, crystal structures, and thermal and electrical properties of materials. The course develops analytical thinking, mathematical interpretation, and problem-solving skills for understanding molecular behaviour, reaction mechanisms, semiconductors, superconductors, and modern materials relevant to research and technological applications.

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Recall the concepts of statistical thermodynamics, chemical kinetics, crystallography, and solid-state properties.
**CO 2:** Explain statistical distributions, reaction mechanisms, crystal structures, and thermal and electrical behaviour of materials.
**CO 3:** Apply thermodynamic, kinetic, and solid-state principles to solve chemical and material science problems.
**CO 4:** Analyze reaction kinetics, crystal defects, conductivity, and superconducting behaviour using theoretical models.
**CO 5:** Evaluate the properties and behaviour of materials, reactions, and solid-state systems for scientific and technological applications.

### Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I:** Statistical Thermodynamics and Applications in Chemistry | **Statistical Thermodynamics:** Limitations of classical thermodynamics. Introduction to terms like microstates, macrostates, ensemble, population, degeneracy. Maxwell-Boltzmann's distribution law, equipartition of energy, partition function, molar partition function, Electronic, Translational, Rotational, and Vibrational partition functions. Applications of statistical thermodynamics- Heat capacity behavior of solid and calculation of equilibrium constant, variation in equilibrium constant with temperature and pressure, Le Chatelier's Principle. Relationship between entropy and probability, Statistical interpretation of chemical equilibrium. | **15** |
| **Unit II:** Chemical Kinetics and Dynamics | **Chemical Kinetics:** Basics of simple chemical kinetics. Reactions approaching equilibrium, steady state approximation, Complex Reactions: Rate laws for consecutive, opposing, parallel, chain reactions. Comparison between gas phase and solution reactions, factors determining rates in solution. Reaction between ions, reactions involving dipoles, reactions in solution. Kinetics of enzyme-catalyzed reactions: Michaelis-Menten mechanism, Lineweaver-Burk plot, Applications of kinetic isotope effects in reaction mechanism studies. Basics of simple collision theory**.** *Activated complex theory*: Reaction coordinate and the transition state theory, potential energy surface, rate constant derivation. Reaction coordinate diagrams and activation parameters ($\Delta H^{\ddagger}$, $\Delta S^{\ddagger}$, $\Delta G^{\ddagger}$). | **15** |
| **Unit III:** Crystalline Materials: From Lattice to | **Solid State Chemistry: Crystallography**- Diffraction properties of crystals. Symmetry elements, space groups. Concept of crystal planes, Miller indices. Ionic crystals. Determination of crystal | **15** |

| | | |
|---|---|---|
| Device | structure. Imperfection in crystals- point defects (Thermodynamic treatment) and line defects. Crystal growth, engineering, polymorphism, and drug polymorphism regulatory issues.<br>**Thermal Properties:** Lattice vibrations - phonon spectrum; Lattice heat capacity; Thermal expansion; Thermal conductivity.<br>**Electrical Properties:** Band theory - band gap - metals and semiconductors - intrinsic and extrinsic semiconductors; Temperature dependence on conductivity. Organic semiconductors, conducting polymers, and perovskites. | |

## CO-PO Mapping Table

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **1** | **1** | **-** | **-** |
| **CO 2** | **3** | **3** | **2** | **-** | **1** |
| **CO 3** | **2** | **2** | **3** | **-** | **1** |
| **CO 4** | **2** | **3** | **3** | **1** | **2** |
| **Average** | **2.5** | **2.25** | **2.25** | **0.25** | **1.0** |

**Correlation levels:**
**1 - Low, 2 - Moderate, 3 - High**

## Justification for CO-PO Mapping

| COs | Justification |
|---|---|
| **CO 1** | This CO develops fundamental understanding of electrochemistry and surface chemistry concepts, strengthening scientific knowledge and basic analytical understanding (**PO1, PO2, PO3**). |
| **CO 2** | This CO enhances conceptual understanding of statistical distributions, reaction mechanisms, and material properties while improving analytical reasoning skills (**PO1, PO2, PO3**). |
| **CO 3** | This CO develops the ability to apply thermodynamic, kinetic, and solid-state concepts for solving advanced chemical and material science problems (**PO2, PO3**). |
| **CO 4** | This CO strengthens analytical and research-oriented thinking through the study of reaction kinetics, crystal defects, conductivity, and superconductivity (**PO2, PO3**) |
| **CO 5** | This CO improves evaluation of materials and solid-state systems for scientific, technological, and interdisciplinary applications (**PO3, PO4, PO5**). |

**Reading references:**


1. M. C. Gupta. *Statistical Thermodynamics*. New Age International Publishers, New Delhi. 1998, Revised Printing.
2. T. L. Hill. *An Introduction to Statistical Thermodynamics*. Dover Publications, New York. 1986, 1st Ed.
3. B. N. Roy. *Fundamentals of Classical and Statistical Thermodynamics*. Wiley, New Delhi. 2002, 1st Ed.
4. K. J. Laidler. *Chemical Kinetics*. Pearson Education, Noida. 1987, 3rd Ed.
5. R. D. Levine. *Molecular Reaction Dynamics*. Cambridge University Press, New York. 2009, Paperback Ed.
6. Raja Ram; J. C. Kuriacose. *Kinetics and Mechanism of Chemical Transformations*. Macmillan India Ltd., New Delhi. 1993, 1st Ed.
7. S. Glasstone. *Textbook of Physical Chemistry*. Macmillan Publishers, London. 1942, 2nd Ed.
8. P. Atkins. *Physical Chemistry*. Oxford University Press, Oxford. 2018, 8th Ed.
9. M. M. Woolfson. *An Introduction to X-ray Crystallography*. Cambridge University Press–Vikas Publishing House, New Delhi. 1980, 2nd Ed.
10. W. Cochran. *Dynamics of Atoms in Crystals*. Edward Arnold, London. 1973. (pp. 24–37).
11. P. M. A. Sherwood. *Vibrational Spectroscopy of Solids*. Cambridge University Press, Cambridge. 1972. (pp. 1-45).
12. C. N. R. Rao; K. J. Rao. *Phase Transitions*. Cambridge University Press, Cambridge. 1st Ed.
13. G. H. Stout; L. H. Jenson. *X-ray Structure Determination: A Practical Guide*. Macmillan Publishing Co. Inc. and Collier Macmillan Publishers, New York. 1989, 2nd Ed.
14. Gurdeep Raj. *Advanced Physical Chemistry*. Krishna Prakashan Media Pvt. Ltd., Meerut. 2022, 1st Ed.

## CH4 104: ANALYTICAL CHEMISTRY-I: INSTRUMENTAL METHODS OF ANALYSIS (L-T-P-C: 3-0-0-3)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** I |
| **Course code:** CH4 104 | **Course name:** ANALYTICAL CHEMISTRY-I: INSTRUMENTAL METHODS OF ANALYSIS |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- This course covers the basics of Analytical Chemistry.
- They will understand the importance of analytical science in real-world applications.
- Learn fundamental knowledge of spectrophotometric techniques
- This course enhances scientific understanding and prepares students for industry roles.
- Students will also learn most of the chromatographic techniques and their principles

**Course Learning Outcomes:** At the end of this course, students will be able to
**CO 1:** Know the importance of Analytical science in the Research & Development of an industry.
**CO 2:** Operate several analytical instruments within a very short period.
**CO 3:** Understand several analytical data representation techniques.
**CO 4:** Learn the techniques to analyze unknown samples.
**CO 5:** Be familiar with several computer-based data plots.

### Syllabus

| Unit | Content | Hours |
|---|---|---|
| **Unit I:** Principles, Errors, and Quality Assurance | Scope of analytical chemistry, Qualitative and quantitative analysis, Accuracy and precision, Types of errors and their causes; Significant figures, Control charts, Confidence limit, Mean deviation, Standard deviation, Coefficient of variance, Rejection of a result- the Q-test. Good Laboratory Practice (GLP), Standard operating procedures, Quality assurance and quality control, Finding the best straight line-least square regression, correlation coefficient; Calibration curves, Concept of reference material internal standards, Measurement uncertainty, traceability, and calibration of analytical instruments. | **15** |
| **Unit II:** Spectrophotometric Methods and Optical Techniques in Chemical Analysis | Properties of light, absorption of light, interaction of light with matter and origin of spectra. The spectrophotometer- calibration, sources of light, monochromators and detectors. Beer's law in chemical analysis, optical rotatory dispersion and circular dichroism, Stoichiometry-method of continuous variation-the Jobs plot, Photometric titrations. Atomic absorption spectroscopy. UV–Visible spectroscopy: instrumentation, applications and quantitative analysis. Introduction to fluorescence spectroscopy and its analytical applications. Factors affecting Beer–Lambert law and causes of deviations. | **15** |
| **Unit-III:** Chromatographic Techniques: Principles, Methods, and Instrumentation | Principles of chromatography, Classification and mechanism of different chromatographic methods, Paper chromatography, Thin layer chromatography, Column chromatography, High-performance thin-layer chromatography, Fast protein liquid chromatography. High performance liquid chromatography, Gas chromatography, Detectors. Applications of chromatographic techniques in pharmaceutical, food and environmental analysis. | **15** |

**Reading references:**

1. D. A. Skoog; D. M. West; F. J. Holler; S. R. Crouch. *Fundamentals of Analytical Chemistry*. Brooks/Cole Publishing, Belmont. 2013, 9th Ed.
2. E. Prichard; V. Barwick. *Analytical Chemistry by Open Learning (Set of 34 Titles)*. Wiley India, New Delhi. 2008,

1st Ed.
3. D. A. Ray; Underwood. *Quantitative Analysis*. Prentice-Hall International Ltd., New Delhi. 1991, 6th Ed.
4. G. H. Jeffery; J. Bassett; J. Mendham; R. C. Denny. *Vogel's Textbook of Quantitative Inorganic Analysis*. Longman Scientific & Technical, Essex. 1989, 5th Ed.
5. G. D. Christian. *Analytical Chemistry*. John Wiley & Sons Inc., New York. 1994, 6th Ed.
6. G. R. Chatwal; S. K. Anand. *Instrumental Methods of Chemical Analysis*. Himalaya Publishing House, Mumbai. 2016, 5th Revised and Enlarged Ed.
7. H. H. Willard; L. L. Merritt; J. A. Dean. *Instrumental Methods of Analysis*. Van Nostrand Reinhold, New York. 1974, 5th Ed.
8. H. Kaur. *Analytical Chemistry*. Pragati Prakashan, Meerut. 2021, Paperback Ed.
9. D. C. Harris. *Quantitative Chemical Analysis*. W. H. Freeman and Company, New York. 1998, 5th Ed.
10. G. D. Christian. *Analytical Chemistry*. John Wiley & Sons Inc., New Jersey. 2004, 6th Ed.
11. D. A. Skoog. *Principles of Instrumental Analysis*. Holt Saunders International Edition, New York. 2016, 7th Ed.
12. G. W. Ewing. *Instrumental Methods of Chemical Analysis*. International Student Edition, New York. 1975, 4th Ed.

## CH4 105: QUANTUM MECHANICS FOR CHEMISTS (L-T-P-C: 3-0-0-3)

| **Program:** M. Sc. Chemistry | **Semester: I** |
|---|---|
| **Course code:** CH4 105 | **Course name:** QUANTUM MECHANICS FOR CHEMISTS |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Description:** In this course, students will learn the basics and advanced part of mathematical tools which generally used to understand the concept of quantum chemistry which will help them to understand the Chemistry of different kind of atoms and molecules. This course will help them to understand the basics of any kind of molecular structure as well as their energy. They will understand the concept and also the approach for different kind of atoms with many electron systems by studying the hydrogen atom and hydrogen-like ions. Students will understand the concept of chemical bonding and different theories for their molecular orbitals.

**Course Learning Outcomes:** At the end of this course students will be able to

**CO 1:** Remember the concept of different mathematical tools and their applications.

**CO 2:** Understand the concept of postulates of quantum, Schrodinger equation and its application, Heisenberg Uncertainty principle, Pauli exclusion principle to understand the basics.

**CO 3:** Apply the concept on different types of problems such as 1D box, harmonic oscillator, hydrogen atom, etc.

**CO 4:** Analyze the concept to evaluate the eigenvalues and eigenfunction of different molecular structures.

**CO 5:** Interpret molecular orbital and valence bond theories, Huckel MO theory and its application

### Detailed Syllabus

| | Content | Hours |
|---|---|---|
| **Unit I:** Linear Vector Space and Structure of Quantum Chemistry | Linear vector space, Matrix representation of Observables and states, Determination of eigenvalues and eigenstate for observables using matrix representations, applications of differential calculus, application of integral calculus, the postulates of quantum mechanics Operators and observables, operators as matrices, significance of eigenvalues and eigenfunctions, Commutation relations, Uncertainty principle. | 15 |
| **Unit II:** Schrödinger Equation and 1D problems | The Schrodinger equation to some model system- particle in a box, the Harmonic oscillator, the rigid rotator, the hydrogen atom, Angular momentum: ordinary angular momentum, generalized angular momentum, Eigen functions for angular momentum, eigenvalues of angular momentum, operator using ladder operators | 15 |
| **Unit III:** Spherically Symmetric Potentials | Pauli matrices and spinors, Identical particles: Indistinguishability, symmetric and antisymmetric wave functions, incorporation of spin, Pauli exclusion principle. Born-Oppenheimer approximation, VB and MO theory, $H_2$+, $H_2$ molecule problem, Hückel molecular orbital theory and its application | 15 |

### CO–PO Mapping Table

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **2** | **-** | **-** | **-** |
| **CO 2** | **3** | **3** | **-** | **-** | **-** |
| **CO 3** | **-** | **3** | **3** | **-** | **-** |
| **CO 4** | **3** | **3** | **3** | **-** | **-** |
| **CO 5** | **3** | **-** | **-** | **2** | **2** |
| **Average** | **2.4** | **2.2** | **1.2** | **0.4** | **0.4** |

### Justification for CO–PO Mapping

| CO | Justification |
|---|---|
| **CO 1** | Understanding mathematical tools used in quantum chemistry develops advanced theoretical knowledge and strengthens logical and critical thinking required for scientific problem solving. (**PO1, PO2**) |
| **CO 2** | Comprehension of quantum mechanical postulates, Schrödinger equation, uncertainty principle, and exclusion principle enhances conceptual understanding and analytical reasoning for solving chemical problems. (**PO1, PO2**) |
| **CO 3** | Application of quantum concepts to model systems such as particle in a box, harmonic oscillator, and hydrogen atom develops problem-solving ability and analytical expertise in scientific calculations. (**PO2, PO3**) |
| **CO 4** | Analysis of eigenvalues and eigenfunctions for molecular systems requires advanced theoretical understanding, critical evaluation, and quantitative analytical skills essential for chemistry research. (**PO1, PO2, PO3**) |
| **CO 5** | Interpretation of molecular orbital, valence bond, and Hückel theories provides foundational knowledge for research-oriented studies, molecular design, and effective scientific communication of chemical concepts. (**PO1, PO4, PO5**) |

**Reading references:**


1. P. Tebbutt. *Basic Mathematics for Chemists*. Wiley, New York. 1998, 2nd Ed.
2. B. Singh. *Mathematics for Chemists*. Pragati Prakashan, Meerut. 2015, 1st Ed.
3. I. N. Levine. *Quantum Chemistry*. Tata McGraw-Hill Publishing Company Ltd., New Delhi. 2002, 5th Ed.
4. A. K. Chandra. *Introductory Quantum Chemistry*. Tata McGraw-Hill Publishing Company Ltd., New Delhi. 1995, 4th Ed.
5. H. C. Verma. *Quantum Physics*. Surya Publications, Ghaziabad. 2009, 2nd Ed.
6. P. W. Atkins. *Molecular Quantum Mechanics: An Introduction to Quantum Chemistry*. Clarendon Press, Oxford. 1970, 1st Ed.
7. D. A. McQuarrie. *Quantum Chemistry*. University Science Books, Sausalito. 2007, 2nd Ed.

## CH4 106: BASIC ORGANIC CHEMISTRY LABORATORY (L-T-P-C: 0-0-8-4)

| **Program:** M. Sc. Chemistry | **Semester:** I |
|---|---|
| **Course code:** CH4 106 | **Course name:** BASIC ORGANIC CHEMISTRY LABORATORY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| - | 8/week | 4 | 120 | Lab | CCE, ESE | 100 | 35 |

**Course Objectives:**

- To separate and purify mixture of organic acids and bases.
- To understand and apply synthetic planning and experimental execution of one or two step synthesis.
- To characterize the organic compounds by use of various analytical techniques like IR, NMR and mass.

**Course Outcomes:** At the end of this course, students will be able to

**CO 1:** Explain the separation and purification techniques used in organic synthesis.
**CO 2:** Illustrate the experimental techniques for one or two step synthesis.
**CO 3:** Apply chromatographic techniques in monitoring and analyzing reaction progress.
**CO 4:** Evaluate the analytical techniques line IR and NMR for characterization of products.
**CO 5:** Demonstrate the synthesis and characterization of a compound

### Detailed Syllabus

| Sr. No. | Name of the Experiment | Hours |
|---|---|---|
| **1** | To Analyse mixture of organic compounds<br>• Analysis of individual components<br>• Ether-soluble component<br>• Ether-insoluble component | **12** |
| **2** | To estimate organic compounds<br>• phenol<br>• aniline<br>• glucose | **12** |
| **3** | To perform thin layer chromatography and determine Retention factor | **12** |
| **4** | To Perform one step synthesis: Benzoin from benzaldehyde | **12** |
| **5** | To prepare and characterize Methyl orange by Diazotization method | **12** |
| **6** | To prepare and characterize aldol condensation product by reaction with benzaldehyde and acetophenone | **12** |
| **7** | To prepare and characterize dibenzalacetone | **12** |
| **8** | To prepare and characterize benzyl alcohol from benzaldehyde by sodium borohydride | **12** |
| **9** | To synthesize and characterize phenylacetic acid by hydrolysis of Benzyl cyanide | **12** |
| **10** | To prepare and characterize benzoic acid by oxidation of benzaldehyde | **12** |

**Reading references:**

1. I. Vogel; B. S. Furniss. *Vogel's Textbook of Practical Organic Chemistry*. Longman Scientific & Technical, Essex. 1989, 5th Ed.
2. F. G. Mann; B. C. Saunders. *Practical Organic Chemistry*. Longman Scientific & Technical, London. 1960, 4th Ed.
3. N. K. Vishnoi. *Advanced Practical Organic Chemistry*. Vikas Publishing House, New Delhi. 2010, 3rd Ed.
4. R. K. Bansal. *Laboratory Manual of Organic Chemistry*. New Age International Publishers, New Delhi. 1983, 5th Ed.

## CH4 107: INORGANIC CHEMISTRY LABORATORY (L-T-P-C: 0-0-8-4)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** I |
| **Course code:** CH4 107 | **Course name:** INORGANIC CHEMISTRY LABORATORY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| - | 8/week | 4 | 120 | Lab | CCE, ESE | 100 | 35 |

**Course Objectives:** The laboratory course focuses on

- Quantitative analysis by gravimetric method
- Emphasize the principles of different redox titrimetric analyses like a) permanganometry, b) dichrometry, c) iodometry

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Demonstrate practical execution of redox titrimetric estimations of different metal ions based on a) Permanganometry, b) Dichoromatometry, c) Iodometry
**CO 2:** Estimation of different ions based on complexometric EDTA titration.
**CO 3:** Determination of different metal ions quantitively by Gravimetric estimation.
**CO 4:** Separation of different ions in a mixture like brass or Dolomite by volumetric estimation

### Syllabus

| Sr. No. | Name of the Experiment | Hours |
|---|---|---|
| 1. | Estimation of Fe(II) in a given solution (Permanganometry).<br>Estimation of Fe(II) with $K_2Cr_2O$(dichromatometry/dichrometry).<br>Estimation of oxalic acid in a given solution by potassium permanganate titration (Permanganometry). | 15 |
| 2. | Estimation of Cu(II) in a solution (Iodometry).<br>Estimation of total hardness of water using EDTA by complexometric method | 15 |
| 3. | Estimate the amount of magnesium present per liter of the given solution of magnesium sulfate<br>To determine the percentage of iron in hematite ore | 15 |
| 4. | To estimate the mass of nickel in the whole of the given nickel ammonium sulfate solution | 15 |
| 5. | Synthesis and analysis of 3d metal complexes.<br>Synthesis and analysis of rare earth metal complexes | 15 |
| 6. | Gravimetric estimation of Cu from a mixture of Cu and Fe solution.<br>Gravimetric determination of Fe in Fe and Cr solution.<br>Gravimetric determination of Ni in Cu and Ni solution. | 15 |
| 7. | Volumetric estimation of Cu in Cu and Ni (German silver).<br>Volumetric estimation of Ca and Mg in Dolomite solution. | 15 |
| 8. | Volumetric estimation of Fe in Cu and Fe solution.<br>Volumetric estimation of Zn in Brass<br>Volumetric estimation of Ni in Ni and Zn solution. | 15 |

### CO-PO Mapping Table

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| CO 1 | 2 | 3 | 3 | - | 1 |
| CO 2 | 2 | 3 | 3 | - | 1 |
| CO 3 | 3 | 3 | 3 | 1 | 1 |
| CO 4 | 2 | 3 | 3 | 1 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| **Average** | **2.25** | **3** | **3** | **0.5** | **1** |

**Correlation levels:**
**1 - Low, 2 - Moderate, 3 - High**

## Justification for CO-PO Mapping

| COs | Justification |
|---|---|
| **CO 1** | Develops practical skills in redox titrimetric analysis and quantitative estimation of metal ions, strengthening analytical and problem-solving abilities (**PO2, PO3**). |
| **CO 2** | Enhances competency in complexometric EDTA titrations for quantitative analysis, promoting technical proficiency and analytical reasoning (**PO2, PO3**). |
| **CO 3** | Develops expertise in gravimetric estimation and synthesis of coordination compounds, reinforcing scientific knowledge, laboratory skills, and research aptitude (**PO1, PO2, PO3, PO4**). |
| **CO 4** | Strengthens the ability to separate and quantitatively estimate metal ions in mixed samples using volumetric methods, improving analytical thinking and scientific investigation skills (**PO2, PO3, PO4**). |

**Reading references:**

1. G. H. Jeffery; J. Bassett; J. Mendham; R. C. Denny. *Vogel's Textbook of Quantitative Chemical Analysis*. Longman Scientific & Technical, Essex. 1989, 5th Ed.
2. G. Svehla. *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*. Orient Longman, Hyderabad. 1982, 5th Ed.

## SEMESTER II

## DETAILED SYLLABUS

### CH4 204: ORGANIC CHEMISTRY-II REACTIONS, REAGENTS AND REARRANGEMENTS (L-T-P-C: 3-0-0-3)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** II |
| **Course code:** CH4 201 | **Course name:** ORGANIC CHEMISTRY-II REACTIONS, REAGENTS, AND REARRANGEMENTS |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- Develop a mechanistic understanding of redox processes
- Explore the reactivity and synthetic utility of organometallic and selective reagents
- Analyze diverse organic rearrangements and reaction pathways

**Course Outcomes:** At the end of this course, students will be able to:
**CO 1**: Explain the mechanisms and stereochemical aspects of organic reactions.
**CO 2:** Analyze molecular rearrangements and their significance in organic chemistry.
**CO 3**: Identify and describe the synthesis, reactions, and properties of heterocyclic compounds.
**CO 4**: Apply knowledge of reaction mechanisms to solve problems in synthesis.
**CO 5**: Demonstrate the applications of heterocyclic compounds in pharmaceuticals, agrochemicals, and materials science.

### Syllabus

| Unit | Content | Hours |
|---|---|---|
| **Unit I:** Organic Reaction Mechanisms – Oxidations and Reductions | **Fundamentals of Redox Reactions in Organic Chemistry:** Electron transfer vs. hydride transfer vs. atom transfer; Redox potential and selectivity; **Mechanistic Insights:** Electron flow (arrow-pushing); Stereoselectivity and chemo/regioselectivity; Transition states, intermediates, catalytic cycles<br>**Oxidation Mechanisms:**<br>**Alcohols → Aldehydes/Ketones/Acids**: PCC, PDC, Dess–Martin, Swern, Jones, $KMnO_4$, TEMPO; **Alkenes and Alkynes**: Epoxidation (m-CPBA, peracids), Dihydroxylation ($OsO_4$, $KMnO_4$), Oxidative cleavage (ozonolysis, $KMnO_4$)<br>**Reduction Mechanisms:**<br>**Carbonyl compounds**: $NaBH_4$, $LiAlH_4$, DIBAL-H; Reductive amination, Birch reduction, Clemmensen, Wolff–Kishner; **Selective reductions**: Rosenmund, Lindlar, Meerwein Ponndorf–Verley<br>**Asymmetric Oxidations and Reductions (Brief Introduction):**<br>Sharpless epoxidation, Corey–Bakshi–Shibata (CBS) reduction | **15** |
| **Unit II:** Reagents in Organic Synthesis | Classification of reagents; about air and moisture sensitive reagents; handling, storage and precaution. Reagent role in stepwise mechanism; Stereocontrol and functional group compatibility; Concept of functional group interconversion (FGI); Chemoselectivity, regioselectivity, and protecting group strategies<br>**Organometallic Reagents:** Grignard, organolithium, organocuprates, Gilman reagents Applications in C–C bond formation; Transition-metal catalysts (Pd, Ru, Rh) and other cross-coupling reagents<br>**Hypervalent iodine reagents**- Various types of hypervalent iodine reagents and their preparation; application in organic transformation, selectivity, sensitivity and reactivity; **Peptide couplingreagents** and their applications. **Functional group protecting agents**– Different types of protecting/masking agents;<br>**Selective and Protective Reagents:** Silyl protecting groups (TBDMS, TMS), Acetals, Carbamates, PMP protection and their deprotection after completion of | **15** |

| | | |
|---|---|---|
| | reaction; **Electrophilic halogenating agents** (NBS, NCS), sulfonation, acylation reagents.<br>**Phase-transfer Catalysts** | |
| **Unit III:** Molecular Rearrangements | Intramolecular vs. Intermolecular; Pericyclic, ionic, and radical pathways; Rearrangement vs. Isomerization; Importance of Rearrangements in installation of Stereocenters and importance of conformational aspects in this regard<br>**Rearrangements Involving Carbocations:**<br>Wagner–Meerwein, Pinacol–Pinacolone, Tiffeneau–Demjanov<br>Benzilic acid and related 1,2-shifts<br>**Rearrangements Involving Carbanions and Ylides:**<br>Favorskii, Wittig, Stevens, Sommelet–Hauser, Ireland–Claisen<br>**Rearrangements Involving Nitrenes:**<br>Curtius, Hofmann, Lossen, Schmidt, Beckmann<br>**Pericyclic Rearrangements (Concerted):**<br>Cope and Claisen rearrangements; Aza–Claisen, Oxy–Cope, Sigmatropic shifts<br>**Oxidative Rearrangements:**<br>Baeyer–Villiger, Dienone–Phenol rearrangement | **15** |

**Reading references:**


1. R. K. Mackie; D. M. Smith; R. A. Aitken. *Guidebook to Organic Synthesis*. Addison-Wesley Longman Ltd., Harlow. 1990, 2nd Ed.
2. H. O. House. *Modern Synthetic Reactions*. W. A. Benjamin, Menlo Park. 1972, 2nd Ed.
3. M. B. Smith. *Organic Synthesis*. Editorial Staff, Boca Raton. 2016, 4th Ed.
4. S. N. Sanyal. *Reactions, Rearrangements, and Reagents*. Bharti Bhawan Publishers, Patna. 2020, 4th Ed.
5. F. A. Carey; R. J. Sundberg. *Advanced Organic Chemistry: Part A Structure & Mechanism*. Springer, New York. 2007, 5th Ed.
6. R. K. Bansal. *Heterocycles*. New Age International Publishers, New Delhi. 2022, 7th Ed.
7. I. L. Finar. *Organic Chemistry Vol. I & II*. ELBS Publication, London. 2002, 5th Ed.
8. M. C. Ray. *Reaction Mechanisms in Organic Chemistry*. MTG Learning Media, New Delhi. 2021, Revised Ed.
9. J. J. Li. *Name Reactions*. Springer, New York. 2018, 4th Ed.
10. C. M. Rojas. *Molecular Rearrangements in Organic Synthesis*. Wiley, Hoboken. 2015, 1st Ed.
11. R. K. Bansal. *Organic Reaction Mechanisms*. New Age International, New Delhi. 2012, 4th Ed.
12. J. March. *Advanced Organic Chemistry*. Wiley India Pvt. Ltd., New Delhi. 2007, 6th Ed.
13. L. M. Harwood. *Advanced Organic Chemistry*. Oxford University Press, Oxford. 1992, 1st Ed.
14. P. S. Kalsi. *Organic Reactions and Their Mechanisms*. New Age International, New Delhi. 2020, 3rd Ed.
15. R. M. Acheson. *An Introduction to the Chemistry of Heterocyclic Compounds*. Wiley Student Edition, New York. 2008, 3rd Ed.
16. J. A. Joule; K. Mills. *Heterocyclic Chemistry*. Wiley, Chichester. 2010, 5th Ed.
17. T. L. Gilchrist. *Heterocyclic Chemistry*. Pearson Education, Harlow. 2005, 3rd Ed.
18. R. R. Gupta; M. Kumar; V. Gupta. *Heterocyclic Chemistry*. Springer, Berlin. 1998, 1st Ed.

## CH4 202: INORGANIC CHEMISTRY-II MAIN GROUP AND ORGANOMETALLIC COMPOUNDS (L-T-P-C: 3-0-0-3)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** II |
| **Course code:** CH4 202 | **Course name:** INORGANIC CHEMISTRY-II MAIN GROUP AND ORGANOMETALLIC COMPOUNDS |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Description:**

- This course deals with the understanding of different periodic properties and periodic anomalies.
- This course provides a detailed study of s- and p-block group elements. This course also focuses on EAN rule and various Carbonyl, nitrosyl metal complexes.

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Define periodic properties and anomalies
**CO 2:** Elaborate discussion of s &p-block ~~group~~ (1-2 &13-18) elements
**CO 3:** Calculate the EAN value of different organometallic compounds
**CO 4:** Summarize bonding, structure and property of different carbonyl-nitrosyl compounds

### Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I:** Periodic trends, structure, bonding | Periodic Trend: Radius, Ionization enthalpy, electron gain enthalpy, electronegativity. Relativistic effects on chemical properties. Hydrogen and its compounds: H-bond and its influence on the structure and properties of crystals Hydrides, classification: electron deficient, electron precise and electron rich hydrides. Concept of ortho and para hydrogen, Alkali and alkaline earth metals: Solutions in liquid ammonia - Synthesis, properties, uses and structures of crown ether complexes, **Group 13 elements:** Borides, borates, boron halides, boranes, carboranes and metallocarboranes, BN compounds, Lewis Base adducts of AlR3 compounds, **Group 14 elements:** Allotropes of Carbon- C60 and its compounds (fullerenes) - carbon nanotubes: synthesis and properties -Intercalation compounds of graphite - Pure Silicon, silica and silicates, Silicones – Low coordinated and hypervalent Silicon compounds - Brief survey of Ge, Sn, and Pb chemistry- Organo-germanium, -tin, and -lead compounds **Group 15 elements:** P(V) compounds (structure, bonding, reactivity)-P(III) compounds: diphosphenes, phosphaalkenes, iminophosphanes - P-containing ring systems (phosphabenzene, phosphole), phosphazenes, Oxo-acids of Phosphrous. Comparison of basicity, reducing property of oxoacids. **Group 16 elements**: Sulfurpolycationic and anionic species - SN compounds. | **15** |
| **Unit II:** Halogens and Nobel gases | **Group 17 elements:** Charge-transfer complexes of halogens, inter-halogen compounds, halogen oxides and oxygen fluorides, pseudo halogens. **Group 18 elements:** Physical properties and reactivity, Xenon compounds: preparation, bonding and structure, noble gas clathrates | **15** |
| **Unit III:** Metal carbonyl and nitrosyl complexes | **Organometallic Chemistry:** Complexes with pi-acceptor and sigma-donor ligands - 16 electron and 18 electron rules– Stability and Reactivity -synergic effect, preparation, Structure, and property of carbonyl, evidence for multiple bonds in Carbonyl compounds, nature of bonding, stretching frequency and ligand effect, Ferrocene. | **15** |

### CO-PO Mapping Table

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **2** | **2** | **-** | **1** |
| **CO 2** | **3** | **2** | **2** | **-** | **1** |
| **CO 3** | **3** | **3** | **3** | **-** | **1** |
| **CO 4** | **3** | **2** | **3** | **1** | **1** |
| **Average** | **3.00** | **2.25** | **2.50** | **0.25** | **1.00** |

**Correlation levels:**
**1 - Low, 2 - Moderate, 3 - High**

## Justification for CO-PO Mapping

| COs | Justification |
|---|---|
| **CO 1** | Develops a strong understanding of periodic properties and periodic anomalies while enhancing analytical interpretation of elemental trends (**PO1, PO2, PO3**). |
| **CO 2** | Strengthens knowledge of the chemistry of s- and p-block elements and their compounds, promoting scientific understanding and analytical skills (**PO1, PO2, PO3**). |
| **CO 3** | Develops the ability to calculate EAN values and analyze the stability of organometallic compounds, enhancing quantitative reasoning and problem-solving skills (**PO1, PO2, PO3**). |
| **CO 4** | Enhances understanding of the bonding, structure, and properties of carbonyl and nitrosyl complexes, fostering analytical thinking and introducing research-oriented concepts in organometallic chemistry (**PO1, PO3, PO4**). |

**Reading references:**


1. A. G. Massey. *Main Group Chemistry*. Wiley, Chichester. 2000, 2nd Ed.
2. N. N. Greenwood; A. Earnshaw. *Chemistry of the Elements*. Pergamon Press, Oxford. 1989, 1st Ed.
3. P. Atkins; T. Overton; J. Rourke; M. Weller; F. Armstrong. *Shriver and Atkins' Inorganic Chemistry*. W. H. Freeman and Company, New York. 2009, 5th Ed.
   **or**
   D. F. Shriver; P. W. Atkins. *Inorganic Chemistry*. W. H. Freeman and Company, New York. 1999, 3rd Ed.
4. C. Housecroft; A. G. Sharpe. *Inorganic Chemistry*. Prentice Hall/Pearson Education, Harlow. 2008, 3rd Ed.
   **or**
   C. Housecroft; A. G. Sharpe. *Inorganic Chemistry*. Prentice Hall/Pearson Education, Harlow. 2012, 4th Ed.
5. F. A. Cotton; G. Wilkinson. *Advanced Inorganic Chemistry*. John Wiley & Sons, New York. 1988, 5th Ed.
   **or**
   F. A. Cotton; C. A. Murillo; M. Bochmann; R. N. Grimes. *Advanced Inorganic Chemistry*. John Wiley & Sons, New York. 1999, 6th Ed.
6. J. E. Huheey; E. A. Keiter; R. L. Keiter. *Inorganic Chemistry: Principles of Structure and Reactivity*. Prentice Hall, New Jersey. 1997, 4th Ed.

## CH4 203: PHYSICAL CHEMISTRY-II: SURFACE AND INTERFACIAL CHEMISTRY (L-T-P-C: 3-0-0-3)

| **Program:** M.Sc. Chemistry | **Semester: II** |
|---|---|
| **Course code:** CH4 203 | **Course name:** PHYSICAL CHEMISTRY-II SURFACE AND INTERFACIAL CHEMISTRY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:** This course aims to provide advanced understanding of surface chemistry, electrochemistry, and catalysis. Students will learn adsorption phenomena, surfactants, electrochemical interfaces, corrosion, catalyst preparation, and characterization techniques while developing analytical and problem-solving skills related to industrial and research applications.

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Explain the principles of adsorption, surface tension, micellization, and interfacial phenomena.
**CO 2:** Apply electrochemical theories and equations to analyze ionic interactions and electrode processes.
**CO 3:** Analyze catalytic mechanisms, catalyst deactivation, and characterization techniques used in surface chemistry.
**CO 4:** Evaluate the importance of electrochemical and catalytic systems in industrial and environmental applications.
**CO 5:** Design approaches for catalyst preparation and characterization using modern analytical techniques.

### Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I:** Surface Sciences | Surface phenomena: surface tension, capillary action pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, Langmuir and Freundlich Adsorption Isotherms, estimation of surface area (BET equation), Catalytic activity at surfaces. Micelles- Surface active agents, classification of surface-active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, solubilisation, micro emulsion, reverse micelles.<br>Colloidal systems: classification, stability, and applications. Applications of surfactants and colloids in pharmaceuticals, cosmetics, food science, detergents, and nanomaterials. | **15** |
| **Unit II:** Electrochemical Interfaces and Applications | **Electrochemistry of solutions:** ionic conductance, electrode potentials, and the Nernst equation. Electroanalytical techniques: cyclic voltammetry, polarography (Ilkovic equation, half-wave potential, and its significance), and their applications in qualitative and quantitative analysis. Electrochemical sensors and biosensors: principles of potentiometric, amperometric, and voltammetric sensors. Applications of electrochemistry in organic synthesis, pharmaceutical analysis, and environmental monitoring. Introduction to corrosion: types, monitoring, and prevention methods. | **15** |
| **Unit III:** Heterogeneous Catalysis | Mechanism of surface reactions. Surface heterogeneity, catalytic activity, selectivity, deactivation, and regeneration of catalysts. Catalyst promotion and poisoning. Zeolites and zeolite-like materials: structure, synthesis, and applications. Basic catalyst characterization techniques (BET surface area, XRD, SEM, and FTIR). Catalysis in Green Chemistry and Sustainability. Nanocatalysis: role of particle size, shape, and support effects. Applications of catalysis in organic synthesis, pharmaceutical manufacturing, and environmental remediation. | **15** |

### CO-PO Mapping Table

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **2** | **1** | **1** | **1** |
| **CO 2** | **3** | **3** | **2** | **1** | **1** |
| **CO 3** | **2** | **3** | **3** | **1** | **1** |
| **CO 4** | **2** | **2** | **3** | **2** | **2** |
| **CO 5** | **2** | **3** | **3** | **2** | **2** |
| **Average** | **2.4** | **2.6** | **2.4** | **1.4** | **1.4** |

**Correlation levels:**
**1 - Low, 2 - Moderate, 3 - High**

## Justification for CO-PO Mapping

| COs | Justification |
|---|---|
| **CO 1** | This CO develops understanding of adsorption, interfacial phenomena, and surface chemistry concepts, strengthening scientific and analytical knowledge (**PO 1, PO 2**). |
| **CO 2** | This CO enhances the application of electrochemical principles and equations for solving problems related to ionic interactions and electrode processes (**PO 2, PO 3**). |
| **CO 3** | This CO develops analytical and research-oriented thinking through the study of catalytic mechanisms and surface characterization techniques (**PO 2, PO 3**). |
| **CO 4** | This CO improves evaluation and problem-solving skills regarding industrial and environmental applications of electrochemical and catalytic systems (**PO 3, PO 4, PO 5**). |
| **CO 5** | This CO promotes innovation and technical competency in catalyst preparation and characterization using modern analytical methods (**PO 2, PO 3, PO 4**). |

**Reading references:**

1. M. J. Schick. *Non-ionic Surfactants*. Surfactant Science Series, Marcel Dekker, New York. 1985, Vol. 72.
2. P. Ghosh. *Colloids and Interface Science*. PHI Learning Pvt. Ltd., New Delhi. 2009, 1st Ed.
3. M. J. Rosen. *Surfactants and Interfacial Phenomena*. John Wiley & Sons, New Jersey. 2004, 3rd Ed.
4. M. R. Porter. *Handbook of Surfactants*. Chapman and Hall, London. 1994, 2nd Ed.
5. A. W. Adamson. *Physical Chemistry of Surfaces*. John Wiley & Sons, New York. 1997, 6th Ed.
6. J. O'M. Bockris; A. K. N. Reddy. *Modern Electrochemistry, Vol. II*. Springer, New York. 2018, 2nd Ed.
7. A. Tager. *Physical Chemistry of Polymers*. Mir Publishers, Moscow. 1978, 1st Ed.
8. H. S. Harned; B. B. Owen. *The Physical Chemistry of Electrolytic Solutions*. Reinhold Publishing, New York. 1950, 1st Ed.
9. S. Glasstone. *Textbook of Physical Chemistry*. Macmillan Publishers, London. 1948, 2nd Ed.

## CH4 204: BIOORGANIC CHEMISTRY (L-T-P-C: 3-0-0-3)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** II |
| **Course Code:** CH4 204 | **Course name:** BIOORGANIC CHEMISTRY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- To understanding the role of biological molecules used in daily life.
- To know and analyze the structure and function of proteins and carbohydrates.
- To discuss the structure, synthesis and application of nucleic acids, lipids and enzymes.

**Course Outcomes**: At the end of this course, students will be able to
**CO 1:** Understand the structure and classification of proteins, lipids, carbohydrates and nucleic acid.
**CO 2:** Learn various structural determination techniques of biomolecules.
**CO 3:** Apply the knowledge of biomolecules in the progression of diseases.
**CO 4:** Demonstrate the role of biomolecules in drug discovery and development.

### Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I:** Protein and Carbohydrates | **Peptides and Proteins:** Building blocks to the Quaternary structure of proteins, structure-stabilizing interactions in secondary structures. α-helix, β-sheets, secondary structures, triple helix structure of collagen. Tertiary structure of protein-folding and domain structure, Peptidomimetics,<br>Carbohydrates: Classification and structure of simple and complex carbohydrates. Isomerization inmonosaccharides, reducing non reducing sugars, anomers, mutarotation, Structural polysaccharides-cellulose and chitin. Storage polysaccharides-starch and glycogen. Structure and biological function of glucosaminoglycans or mucopolysaccharides. | **15** |
| **Unit II:** Nucleic Acids and Lipids | **Nucleic Acids:** Detailed Structure of nucleic acids, Different types of DNA, the double helix model of DNA, and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. Chemical synthesis of mono and tri-nucleosides.<br>**Lipids:** Classification, chemical structure, and biological functions of lipids, glycerol phospholipids, sphingolipids, cholesterol, bile acids, prostaglandins, Lipoproteins-composition and function, role in atherosclerosis. Properties of lipid aggregates-micelles, bilayers, liposomes, and their possible biological function. | **15** |
| **Unit III:** Enzymes | Enzymes, Coenzymes, enzyme-kinetics, metalloenzymes, applications of enzymes in organic synthesis, enzyme-models and applications. Enzyme-catalyzed carboxylation and decarboxylation reactions. Enzyme inhibition and drug design, Molecular recognition, chiral recognition, crown ethers, cryptands, host-guest chemistry. | **15** |

**Reading references:**

1. L. Lehninger. *Principles of Biochemistry*. Worth Publishers, New York. 2007, 7th Ed.
2. L. Stryer. *Biochemistry*. W. H. Freeman and Company, New York. 2019, 5th Ed.
3. D. Voet; J. G. Voet. *Biochemistry*. John Wiley & Sons, New York. 2010, 3rd Ed.
4. J. L. David; J. Rawn. *Biochemistry*. Neil Patterson Publishers, North Carolina. 1989, International Ed.
5. E. E. Conn; P. K. Stumpf. *Outlines of Biochemistry*. John Wiley & Sons, New York. 2006, 5th Ed.
6. T. Palmer. *Understanding Enzymes*. Prentice Hall, London. 1995, 2nd Ed.

7. C. H. Collins; J. Suckling. *Enzyme Chemistry: Impact and Applications*. Chapman and Hall, London. 1990, 2nd Ed.
8. U. Satyanarayana; U. Chakrapani. *Essentials of Biochemistry*. Elsevier Health Sciences, New Delhi. 2021, 3rd Ed.
9. R. K. Murray; V. W. Rodwell; D. Bender; K. M. Botham; P. A. Weil; P. J. Kennelly. *Harper's Illustrated Biochemistry*. McGraw Hill Professional, New York. 2009, 28th Ed.

## CH4 205: SPECTROSCOPY-I: MOLECULAR STRUCTURE ELUCIDATION (L-T-P-C: 3-0-0-3)

| **Program:** M. Sc. Chemistry | **Semester:** II |
|---|---|
| **Course Code:** CH4 205 | **Course name:** SPECTROSCOPY-I: MOLECULAR STRUCTURE ELUCIDATION |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3/week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Description:**

- Understand the principles, instrumentation, and interpretive strategies of UV-Vis, IR, NMR ($^{1}H$ and $^{13}C$), and mass spectrometry
- To correlate spectral data with molecular structure and functional groups
- Apply spectroscopic techniques to differentiate isomers, elucidate structures, and analyze mixtures
- To train students in the application of spectroscopic techniques for qualitative and quantitative analysis in chemistry, pharmaceuticals, materials science, and related research areas.

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Remember the basic concept of Vibrational, UV, IR, 1H and Mass spectroscopy
**CO 2:** Analyze and assign 1H NMR and 13C NMR spectra, including chemical shifts, coupling patterns, integration, stereochemical effects, and structure determination of organic compounds.
**CO 3:** Apply mass spectrometric principles to determine molecular weight, molecular formula, isotopic patterns, and fragmentation pathways of organic
**CO 4:** Analyze the UV, IR,$^{1}H$ NMR and Mass spectra

### Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I:** UV and IR Spectroscopy | **UV, and IR Spectroscopy** –<br>**UV Spectroscopy:** Origin of electronic spectra, Lambert-Beer's absorption law, Types of electronic transitions. Principle of UV spectroscopy and instrumentation. Effect of solvent, substituent, and conjugation on electronic transitions. Factors affecting the position and intensity of bands and λmax, Chromophores and auxochromes, Benzene and its substituted derivatives. Applications of UV-visible spectroscopy in analysis (qualitative/quantitative) of polyenes/aromatic (hetero & homo) systems, geometrical isomers, keto-enol tautomer's, components of a mixture. Woodward-Fieser rules for calculating absorption maximum in dienes, trienes, α, β-unsaturated carbonyl compounds and aromatic compounds. Applications of UV-Vis spectroscopy in reaction kinetics, photochemistry, pharmaceuticals, sensors, and materials chemistry.<br>**IR Spectroscopy:** Instrumentation–sources-sampling techniques. Factors influencing IR spectroscopy, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. Differentiation of compounds/isomers by IR. Application of IR spectroscopy and limitations.<br>Introduction to fluorescence spectroscopy | **15** |
| **Unit II:** NMR Spectroscopy | **$^{1}H$ NMR Spectroscopy**: Introduction, Definition, Chemical shift and factor affecting chemical shift, spin-spin interaction, shielding and deshielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, carbonyl and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), coupling constants – vicinal, geminal, long | **15** |

| | | |
|---|---|---|
| | range and virtual couplings, Intensity of signal (Peak area or integration) the effect of deuteration, Solvent effects in NMR, Practical aspects of sample preparation. complex spin-spin interaction between two, three nuclei. Stereochemistry, hindered rotation, Karplus curve variation of coupling constant with dihedral angle.<br>**$^{13}$C NMR Spectroscopy**:$^{13}$C NMR, introduction to FT technique, relaxation phenomena, NOE effects, $^{1}$H and $^{13}$C chemical shifts to structure correlations. Chemical shift and (Aliphatic, olefinic, Alkyne, Aromatic, Heteroaromatic and carbonyl carbon), Coupling constants. To identify structure from $^{13}$C NMR data; Use of $^{13}$C spectra in differentiating compounds/isomers. Difference between $^{1}$H NMR and $^{13}$C NMR | |
| **Unit III:** Mass Spectrometry | **Mass Spectrometry -** Origin of mass spectrum, principles of EI mass spectrometer-Instrumentation. Preliminary account of chemical ionization, Soft ionization techniques: Chemical Ionization (CI), Electrospray Ionization (ESI), and MALDI. Types of fragments: odd electron and even electron containing neutral and charged species (even electron rule, Nitrogen rule, isotopic peaks, metastable ion peaks, determination of molecular formula and High-resolution mass spectrometry. Salient features of the fragmentation pattern of organic compounds- α-cleavage, β cleavage, McLafferty rearrangement, Fragmentation patterns of important functional groups such as hydrocarbons, aromatic compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amides, amines, and halo compounds. | **15** |

**Reading references:**


1. C. N. Banwell; E. M. McCash. *Fundamentals of Molecular Spectroscopy*. McGraw-Hill Education, New Delhi. 2011, 4th Ed.
2. G. Aruldhas. *Molecular Structure and Spectroscopy*. Prentice Hall of India, New Delhi. 2004, 2nd Ed.
3. R. M. Silverstein; F. X. Webster; D. J. Kiemle; D. L. Bryce. *Spectroscopic Identification of Organic Compounds*. John Wiley & Sons, New York. 2014, 8th Ed.
4. Y. R. Sharma. *Elementary Organic Spectroscopy*. S. Chand & Company Ltd., New Delhi. 2007, Revised Ed.
5. R. Kakkar. *Atomic and Molecular Spectroscopy*. Cambridge University Press, Cambridge. 2015, 1st Ed.
6. W. Kemp. *Organic Spectroscopy*. Macmillan, London. 1994, 3rd Ed.
7. D. H. Williams; I. Fleming. *Spectroscopic Methods in Organic Chemistry*. McGraw-Hill Education, London. 1995, 5th Ed.
8. A. B. Derome. *Modern NMR Techniques for Chemistry Research*. Pergamon Press, Oxford. 1987, Reprinted Ed.
9. D. L. Pavia. *Introduction to Organic Spectroscopy*. Cengage India Pvt. Ltd., New Delhi. 2015, 5th Ed.
10. G. C. Levy; O. L. Nelson. *Carbon-13 NMR for Organic Chemists*. Wiley, New York. 1980, 2nd Ed. and
    Atta-ur-Rahman. *Nuclear Magnetic Resonance: Basic Principles*. Springer-Verlag, New York. 2011, 1st Ed.
11. P. S. Kalsi. *Spectroscopy of Organic Compounds*. New Age International Pvt. Ltd., New Delhi. 2020, 8th Ed.

## CH4 206: ANALYTICAL TECHNIQUES LABORATORY (L-T-P-C: 0-0-8-4)

| **Program:** M. Sc. Chemistry | **Semester:** II |
|---|---|
| **Course code:** CH4 206 | **Course name:** ANALYTICAL TECHNIQUES LABORATORY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| - | 8 per week | 4 | 120 | Lab | CCE, ESE | 100 | 35 |

**Course Objectives:**

- To understand and learn analytical techniques in biochemical studies.
- To separate and identify biomolecules such as amino acids, carbohydrates, and proteins.
- To determine the iodine value of lipids
- To determine the concentration of biomolecules in tea and coffee

**Course Learning Outcomes:** At the end of this course students will be able to
**CO 1:** Demonstrate proficiency in techniques for the separation and identification of biomolecules, including amino acids and sugars.
**CO 2:** Quantify biomolecules using standard methods like Anthrone and Lowry's techniques.
**CO 3:** Evaluate lipid properties through determination of iodine and acetyl numbers.
**CO 4:** Analyze organic compounds using spectroscopic methods, including UV-visible and IR spectroscopy.
**CO 5:** Compare and interpret shifts in electronic absorption spectra under varying chemical conditions.

### Syllabus

| Sr. No. | Name of the Experiment | Hours |
|---|---|---|
| **1.** | Determination of Isoelectronic point (PI) of Amino acid by titration method. | **8** |
| **2.** | Characterize mono- and disaccharides by recrystallization, solubility, melting points, and crystal morphology. | **8** |
| **3.** | Estimation of total sugar in biological samples using the Anthrone method involving spectrophotometric detection. | **8** |
| **4.** | Estimation of amino acids using Ninhydrin-Anthrone method involving colorimetric analysis. | **8** |
| **5.** | Estimation of protein by Lowery's method | **8** |
| **6.** | Determination of Iodine number and acetyl number of Lipid molecules. | **8** |
| **7.** | Separation of amino acids by paper chromatography | **8** |
| **8.** | Study the bathochromic shift of p-nitrophenol in UV-Vis spectra under alkaline vs. neutral conditions to assess pH-dependent resonance effects. | **8** |
| **9.** | Study the hypsochromic shift in aniline by comparing its UV-Vis spectra in neutral and acidic media. | **8** |
| **10.** | Compare IR spectra of acetone and benzophenone to distinguish aliphatic and aromatic ketones based on key vibrations. | **8** |
| **11.** | Comparative IR Analysis of Aromatic and aliphatic Nitro compounds, Amines, Nitriles and Amides | **8** |
| **12.** | Analyze unknown organic samples to identify alcohols, acids, amines, or esters based on diagnostic IR bands | **8** |
| **13.** | UV- Vis Spectrophotometric Analysis of caffeine and benzoic acid in soft drinks via Beer's Law. | **8** |
| **14.** | Assign $^1$H NMR peaks of common compounds using chemical shift, splitting, and integration with software or spectra. | **8** |
| **15.** | Record and analyze spectra of complexes like $[Cu(NH_3)_4]^{2+}$ or $[Fe(SCN)]^{2+}$ to observe d–d transitions and ligand effects. | **8** |

**Reading references:**

1. R. Katoch. *Analytical Techniques in Biochemistry and Molecular Biology*. Springer, New York. 2011, 1st Ed.

2. H. Martin. *Basic Methods for the Biochemical Lab*. Springer, Berlin. 2007, 1st Ed.
3. K. Wilson; J. Walker. *Principles and Techniques in Biochemistry and Molecular Biology*. Cambridge University Press, Cambridge. 2010, 7th Ed.
4. J. A. A. Chambers; D. Rickwood. *Biochemistry Lab Fax*. Blackwell Science, Oxford. 1993, 1st Ed.
5. T. S. Work; E. Work. *Laboratory Techniques in Biochemistry and Molecular Biology, Vol. I & II*. North-Holland Publishing Company, Amsterdam. 1970, 1st Ed.
6. R. K. Bansal. *Practical Organic Chemistry*. New Age International Pvt. Ltd., New Delhi. 2008, 5th Ed.
7. D. Field; S. Sternhell; J. R. Kalman. *Organic Structures from Spectra*. John Wiley & Sons Ltd., Chichester. 2008, 4th Ed.
8. F. G. Mann; B. C. Saunders. *Practical Organic Chemistry*. Pearson Education India, New Delhi. 2009, 4th Ed.
9. W. Kemp. *Organic Spectroscopy*. Macmillan, London. 1994, 3rd Ed.
10. P. S. Kalsi. *Spectroscopy of Organic Compounds*. New Age International Publishers, New Delhi. 2007, 6th Ed.
11. Y. R. Sharma. *Elementary Organic Spectroscopy – Principles and Chemical Applications*. S. Chand & Company Ltd., New Delhi. 1992, 5th Ed.

## CH4 207: PHYSICAL CHEMISTRY LABORATORY (L-T-P-C: 0-0-8-4)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** II |
| **Course code:** CH4 207 | **Course name:** PHYSICAL CHEMISTRY LABORATORY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| - | 8/week | 4 | 120 | Lab | CCE, ESE | 100 | 35 |

**Course Objectives:** This laboratory course aims to provide practical knowledge of electrochemistry, surface chemistry, conductometry, potentiometry, kinetics, and related physical chemistry techniques. Students will develop experimental, analytical, and data interpretation skills through laboratory experiments and modern instrumental methods.

**Course Outcomes:** At the end of this course, students will be able to
**CO 1:** Explain the principles of conductometry, potentiometry, viscometry, spectroscopy, and electrochemistry used in laboratory experiments.
**CO 2:** Perform quantitative analysis and kinetic studies using modern physical chemistry experimental techniques.
**CO 3:** Analyze experimental data to determine thermodynamic, kinetic, and electrochemical parameters.
**CO 4:** Evaluate the accuracy and reliability of experimental observations using appropriate error analysis and interpretation methods.
**CO 5:** Design and execute laboratory experiments related to solution chemistry, surfactants, and reaction kinetics.

### Syllabus

| Sr. No. | Name of the Experiment | Hours |
|---|---|---|
| **1.** | Conductometric Determination of the Percentage Composition of Strong and Weak Acids in a Mixture | **8** |
| **2.** | Conductometric Determination of the Rate Constant and Activation Energy for the Hydrolysis of Methyl Acetate | **8** |
| **3.** | To determine the relative strengths of the given strong acids by studying the kinetics of inversion of cane sugar using the polarimetric method. | **8** |
| **4.** | Determination of the Viscosity Average Molecular Weight of a Polymer Using Ostwald's Viscometer | **8** |
| **5.** | To determine the Redox potential of Fe(II)/Fe(III) system by potentiometric method. (pH metry)<br>Or,<br>Potentiometric Determination of KCl and KI Concentrations in a Mixture Using Standard $AgNO_3$ Solution | **8** |
| **6.** | Potentiometric Determination of the Strength of an Unknown Silver Nitrate ($AgNO_3$) Solution | **8** |
| **7.** | pH-Metric Determination of the Dissociation Constants ($pK_1$ and $pK_2$) of a Dibasic Acid | **8** |
| **8.** | Conductometric Determination of the Solubility Product ($K_{sp}$) of Barium Sulfate and Silver Chloride. | **8** |
| **9.** | Potentiometric Determination of the Dissociation Constants of Monobasic Acids: Acetic Acid, Benzoic Acid, and Salicylic Acid | **8** |
| **10.** | Kinetic study of the esterification of an alcohol by NMR Spectroscopy. (Chemical kinetics) | **8** |
| **11.** | Determination of Critical Micelle Concentration (CMC) and Thermodynamics of Micellization | **8** |
| **12.** | Conductometric Determination of the Critical Micelle Concentration (CMC) of Sodium Dodecyl Sulfate (SDS) | **10** |

| | | |
|---|---|---|
| **13.** | Characterization of a catalyst or nanomaterial using available instrumentation (FTIR, XRD, UV–Vis, or SEM data interpretation).Adsorption isotherm of acetic acid or oxalic acid on activated charcoal (Langmuir/Freundlich isotherm). | **10** |
| **14.** | Evaluation of the catalytic activity of a heterogeneous catalyst (e.g., $MnO_2$ decomposition of $H_2O_2$ or KI-catalyzed reaction). | **10** |

## CO-PO Mapping Table

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 |
|---|---|---|---|---|---|
| **CO 1** | **3** | **2** | **1** | **1** | **1** |
| **CO 2** | **2** | **3** | **2** | **3** | **2** |
| **CO 3** | **2** | **3** | **3** | **2** | **2** |
| **CO 4** | **1** | **2** | **3** | **3** | **2** |
| **CO 5** | **1** | **3** | **3** | **3** | **3** |
| **Average** | **2.0** | **2.5** | **2.25** | **2.25** | **2.0** |

**Correlation levels:**
**1 - Low, 2 - Moderate, 3 - High**

## Justification for CO-PO Mapping

| COs | Justification |
|---|---|
| **CO 1** | This CO develops understanding of experimental principles and physical chemistry laboratory techniques, strengthening scientific and analytical knowledge (**PO 1, PO 2**). |
| **CO 2** | This CO enhances practical laboratory competency and application of physical chemistry techniques for quantitative analysis and kinetic studies (**PO 2, PO 4**). |
| **CO 3** | This CO develops analytical and interpretation skills through the analysis of thermodynamic, kinetic, and electrochemical experimental data (**PO 2, PO 3**). |
| **CO 4** | This CO strengthens evaluation and problem-solving abilities through error analysis and interpretation of laboratory observations (**PO 3, PO 4**). |
| **CO 5** | This CO promotes innovation and experimental design skills related to solution chemistry, surfactants, and reaction kinetics (**PO 3, PO 4, PO 5**). |

**Reading references:**

1. B. D. Khosla; V. C. Garg. *Senior Practical Physical Chemistry*. R. Chand & Co., New Delhi. 2018, 18th Ed.
2. B. Viswanathan; P. S. Raghavan. *Practical Physical Chemistry*. Viva Books Pvt. Ltd., Navi Mumbai. 2017, 1st Ed.
3. A. K. Nad; B. Mahapatra; A. Ghoshal. *An Advanced Course in Practical Chemistry*. New Central Book Agency Pvt. Ltd., Kolkata. 2012, 3rd Ed.
4. J. N. Gurtu; A. Gurtu. *Advanced Physical Chemistry Experiments*. Pragati Prakashan, Meerut. 2008, 1st Ed.

**~:The End:~**

# Indrashil University


## Department of Chemistry
## School of Science

## M.Sc. 2026-2028 Sem III-IV

## Organic Chemistry

## Course Profile

## Academic Year 2026-2027

## Course Structure M.Sc. Organic Chemistry Semesters III and IV

| SEMESTER: III | MINIMUM SEMESTER CREDIT REQUIRED: 24 CUMULATIVE SEMESTER CREDITS REQUIRED: 67 | | |
|---|---|---|---|
| **SUBJECT CODES** | **SUBJECT NAMES** | **L-T-P** | **CREDITS** |
| CH5 OR101 | ORGANIC CHEMISTRY – III: ORGANOMETALLIC CHEMISTRY AND ASYMMETRIC SYNTHESIS | 3-0-0 | 3 |
| CH5 OR102 | ORGANIC CHEMISTRY – IV: CHEMISTRY OF NATURAL PRODUCTS | 3-0-0 | 3 |
| CH5 OR103 | ORGANIC CHEMISTRY – V: PERICYCLIC REACTIONS AND ORGANIC PHOTOCHEMISTRY | 3-0-0 | 3 |
| CH5 104 | SPECTROSCOPY-II: ADVANCED NMR AND MOLECULAR SPECTROSCOPY | 3-0-0 | 3 |
| CH5 105 | SPECTROSCOPY ANALYSIS & DATA INTERPRETATION LABORATORY | 0-0-8 | 4 |
| CH5 OR106 | ADVANCED ORGANIC CHEMISTRY LAB | 0-0-8 | 4 |
| | ELECTIVE-I | 2-0-0 | 2 |
| | ELECTIVE-II | 2-0-0 | 2 |
| **Total** | | **16L-16P** | **24** |

| SEMESTER: IV | MINIMUM SEMESTER CREDIT REQUIRED: 15 CUMULATIVE SEMESTER CREDITS REQUIRED: 82 | | |
|---|---|---|---|
| **SUBJECT CODES** | **SUBJECT NAMES** | **L-T-P** | **CREDITS** |
| CH5 OR201 | RESEARCH OR INDUSTRIAL PROJECT | 0-0-20 | 10 |
| CH5 OR202 | PROJECT REPORT | 3-0-0 | 3 |
| CH5 OR203 | PROJECT PRESENTATION | 2-0-0 | 2 |
| **Total** | | **5L-20P** | **15** |

## Semester III: LIST OF AVAILABLE SUBJECTS FOR ELECTIVE I, II

| SUBJECT CODES | SUBJECT NAMES | L-T-P | CREDIT |
|---|---|---|---|
| CH5 EOR1 | MEDICINAL CHEMISTRY | 2-0-0 | 2 |
| CH5 EOR2 | APPLICATIONS OF COMPUTERS IN CHEMISTRY | 2-0-0 | 2 |
| CH5 EOR3 | SUPRAMOLECULAR CHEMISTRY | 2-0-0 | 2 |
| CH5 EOR4 | INDUSTRIAL CHEMICAL METHODS AND ANALYSIS | 2-0-0 | 2 |
| CH5 EOR5 | ARTIFICIAL INTELLIGENCE IN CHEMISTRY | 2-0-0 | 2 |

## SEMESTER III
## SYLLABUS WITH COURSE LEARNING OUTCOME (CLO)

**CH5 OR101: ORGANIC CHEMISTRY III (L-T-P-C: 3-0-0-3)**

| | |
|---|---|
| **Program:** M. Sc. Chemistry (Organic) | **Semester:** III |
| **Course code:** CH5 OR101 | **Course name:** ORGANIC CHEMISTRY – III: ORGANOMETALLIC CHEMISTRY AND ASYMMETRIC SYNTHESIS |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3 per week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- Understand the fundamental principles of organometallic bonding, reactivity, and catalytic cycles
- Explore the design and application of metal-catalyzed and organocatalytic asymmetric transformations
- Apply retrosynthetic analysis and modern catalytic approaches

**Course Outcomes:** At the end of this course, students will be able to
**CO 1:** Understand the principles of retrosynthetic analysis in the synthesis of natural product
**CO 2:** Describe the protection/de-protection strategy in organic synthesis
**CO 3:** Explain the utility of organometallic compounds in fine chemicals
**CO 4:** Demonstrate the various aspects of asymmetric synthesis
**CO 5:** Apply organic synthesis principles in complex molecule synthesis

### Syllabus

| Unit | Content | Hours |
|---|---|---|
| Unit I: Advanced Organometallic Chemistry | Organometallic Compounds in organic synthesis: classification, and scope of various organometallics reagents; reaction mechanism involving organometallic reagents: oxidative addition, reductive elimination, migratory insertion, σ-bond metathesis, β-hydride elimination<br>Cross-Coupling Reactions involving organometallic reagents: Heck, Suzuki–Miyaura, Stille, Negishi, Sonogashira, Buchwald–Hartwig. Wacker oxidation, Catalytic Activity and usage of Wilkinson's Catalyst, Olefin metathesis: RCM by Grubbs 1st, and 2nd generation catalysts<br>Difference between C–H activation C-H Fuctionalization: Applications of Organometallic/Palladium catalysis in Organic Synthesis: The power of organometallic<br>Chemistry as a versatile tool in the synthesis | **15** |
| Unit II: Asymmetric Synthesis | Basics Strategies of chiral synthesis : Concepts of chirality, stereoselectivity, asymmetric induction Approaches involving chiral substrates, auxiliaries chiral pool, and Catalysts<br>Metal-catalyzed Asymmetric Catalysis: asymmetric hydrogenation (olefins, imines), Sharpless epoxidation/diol, Jacobsen, Shi); Shibasaki's heterobimetallic lanthanide-based chiral catalysts. Examples of C–C Bond Forming reactions with Asymmetric Catalysis E.g. Asymmetric aldol, Michael, and Cycloaddition Reactions<br>Resolutions & Kinetic Control: Classical and enzymatic/chemical resolution strategies (KR, DKR)<br>Synthesis of (S)-Naproxen, a widely known NSAID (non-steroidal anti-inflammatory drug). | **15** |
| Unit III: Resolution | Introduction & Activation Modes: Enamine catalysis; | **15** |

| | | |
|---|---|---|
| Strategies | Iminium catalysis; Hydrogen-bonding (thioureas, Brønsted acids) Enantioselective Organocatalytic Transformations<br>Aldol & Michael reactions via enamine catalysis; Diels–Alder & epoxidation using iminium/H-bonding catalysts; Transfer hydrogenation with MacMillan catalysts and Hantzsch ester;<br>Kinetic & dynamic resolution: examples in organocatalysis<br>Photoredox organocatalysis and electrochemical synthesis | |

**Reading references:**


1. W. Carruthers. *Modern Methods of Organic Synthesis*. Cambridge University Press, Cambridge. 2004, 4th Ed.
2. R. K. Mackie; D. M. Smith; R. A. Aitken. *Guidebook to Organic Synthesis*. Prentice Hall, Harlow. 1999, 3rd Ed.
3. H. O. House. *Organic Synthesis*. McGraw-Hill Book Company, New York. 1972, 2nd Ed. *(Edition added for completeness - confirm if another is intended)*
4. M. B. Smith. *Organic Synthesis*. Editorial Staff, Boca Raton. 2016, 4th Ed.
5. F. A. Carey; R. J. Sundberg. *Advanced Organic Chemistry: Part A Structure & Mechanism*. Springer, New York. 2007, 5th Ed.
6. M. B. Smith. *Advanced Organic Chemistry*. John Wiley & Sons, Hoboken. 2015, 7th Ed.
7. J. Mann; R. S. Davidson; J. B. Hobbs. *Natural Products: Chemistry and Biological Significance*. Longman Group, Harlow. 1994, 1st Ed.
   **and**
   I. L. Finar. *Organic Chemistry Vol. 2*. ELBS, London. 1994, 5th Ed. *(clarified from "Vol 2")*
8. M. Nógrádi. *Stereoselective Synthesis: A Practical Approach*. Wiley-VCH Verlag GmbH, Weinheim. 1994, 2nd Ed.
9. Atta-ur-Rahman; M. I. Choudhary. *New Trends in Natural Product Chemistry*. Harwood Academic Publishers, Amsterdam. 1986, 2nd Ed.

## CH5 OR102: ORGANIC CHEMISTRY – IV: CHEMISTRY OF NATURAL PRODUCTS (L-T-P-C: 3-0-0-3)

| **Program:** M. Sc. Chemistry | **Semester:** III |
|---|---|
| **Course code:** CH5 OR102 | **Course name:** ORGANIC CHEMISTRY – IV: CHEMISTRY OF NATURAL PRODUCTS |

| **Lecture (Hours)** | **Practical (Hours)** | **Credits** | **Total Hours** | **Evaluation Scheme** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Component** | **Exam** | **Max. Marks** | **Passing %** |
| 3 per week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- To know and understand concept of retrosynthetic analysis.
- To know and study structure and synthesis of terpenoids and alkaloids.
- To utilize the knowledge of natural products in industrial processes.

**Course Outcomes:** At the end of this course students will be able to

**CO 1:** Understand the concept of retrosynthetic analysis and various terminologies.
**CO 2:** Apply retrosynthetic analysis for complex terpenoids and alkaloids.
**CO 3:** Analyze structure and synthesis of important terpenoids and alkaloids.
**CO 4:** Analyze structure and synthesis of steroids and prostaglandins
**CO 5:** Demonstrate role of alkaloids in pharmaceutical development

### Detailed Syllabus

| **Units** | Content | **Hours** |
|---|---|---|
| **Unit I: Retrosynthetic Analysis** | **Retrosynthesis:** Introduction, Terminologies in Retrosynthesis, Synthetic equivalents. One and two functional group C-C & C-X disconnections, Criteria for selection of target molecule, Functional group interconversion, Synthetic tree, Latent polarity, Linear and convergent synthesis. Retrosynthetic analysis involving chemo-, regio- and stereoselectivities. Umpolung in organic synthesis. Application of retrosynthetic strategy in the synthesis of the following – (S) Propanediol, (R) and (S) – Epichlorohydrin, L (+)-Alanine, Saccharine, AI and Software Solutions for Retrosynthesis | **15** |
| **Unit II: Terpenoids and Alkaloids** | **Terpenoids:** Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis, and synthesis of the following representative molecules: Citral, Menthol, Santonin, and B-Carotene.<br>**Alkaloids:** Occurrence, nomenclature, and physiological action, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring. Structure, stereochemistry, synthesis, and biosynthesis of: Ephedrine, (+)-Nicotine, and Morphine. Alkaloids as medicinal agents, health benefits and side effects | **15** |
| **Unit III: Steroids and Prostaglandins** | **Steroids:** Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Estrone, Biosynthesis of steroids.<br>**Prostaglandins:** Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE2 and PGF2a. Synthesis and reactions of Pyrethroids and Rotenones. Prostaglandins in drug development and healthcare | **15** |

**Reading references:**

1. J. Mann; R. S. Davidson; J. B. Hobbs. *Natural Products: Chemistry and Biological Significance*. Longman Group, Harlow. 1994, 1st Ed. and
   I. L. Finar. *Organic Chemistry, Vol. 2*. ELBS, London. 1994, 5th Ed.
2. I. L. Finar. *Organic Chemistry, Vol. 2*. Pearson Education, New Delhi. 2022, 6th Ed.

3. K. Hostettmann (Ed.); M. P. Gupta; A. Marston. *Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas*. Harwood Academic Publishers, Amsterdam. 1999, 1st Ed.
4. Atta-ur-Rahman; M. I. Choudhary. *New Trends in Natural Product Chemistry*. Harwood Academic Publishers, Amsterdam. 1986, 2nd Ed.
5. B. G. Torssell. *Natural Product Chemistry: A Mechanistic, Biosynthetic and Ecological Approach*. Swedish Pharmaceutical Press, Stockholm. 1997, 1st Ed.
6. V. Sujata; B. A. Bhat; S. Nagasampagi; S. Meenakshi. *Natural Products: Chemistry and Applications*. Narosa Publishing House, New Delhi. 2011, 1st Ed.
7. O. P. Agarwal. *Organic Chemistry: Natural Products, Volume II*. Krishna Prakashan Media Pvt. Ltd., Meerut. 2011, 1st Ed.

## CH5 OR103: ORGANIC CHEMISTRY – V: PERICYCLIC REACTIONS AND ORGANIC PHOTOCHEMISTRY (L-T-P-C: 3-0-0-3)

| **Program:** M. Sc. Chemistry | **Semester:** III |
|---|---|
| **Course code:** CH5 OR103 | **Course name:** ORGANIC CHEMISTRY – V: PERICYCLIC REACTIONS AND ORGANIC PHOTOCHEMISTRY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3 per week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objective:**

- **Course** deals with the understanding of the concept of pericyclic and photochemistry.
- Course also covers various pericyclic reactions, applications of free radicals and photochemistry of organic compounds.
- To explain the stereochemistry and regioselectivity of electrocyclic, cycloaddition, and sigmatropic reactions.
- Course will cover important name reaction of pericyclic, photochemistry
- To explore the synthetic applications of pericyclic and photochemical reactions in organic chemistry.

**Course Learning Outcomes:** At the end of this course students will be able to

**CO 1:** Explain the principles and mechanisms of pericyclic and photochemical reactions.

**CO 2:** Predict the stereochemical outcomes of electrocyclic, cycloaddition, and sigmatropic reactions using orbital symmetry concepts

**CO 3:** Analyze photochemical transformations of carbonyl compounds, olefins, and aromatic systems.

**CO 4:** Interpret reaction pathways and products of pericyclic and photochemical reactions in organic synthesis.

### Detailed Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I:** Pericyclic Reactions | **Pericyclic Reactions:** Introduction and classification of pericyclic reactions, Orbitals, molecular orbital symmetry, molecular orbital of ethylene, 1,3-butadiene, 1,3,5–hexatriene and allyl systems, FMO Approach, Woodward-Hoffman correlation diagram method and PMO approach for pericyclic reactions under thermal and photochemical conditions.<br>**Electrocyclic Reaction**: concerted reactions, Conrotatory and disrotatory motion, 4n and (4n+2) systems for ring opening and ring closure,<br>**Cycloaddition Reaction:** [2+2] and [4+2] cycloaddition reaction, selection rules through construction of correlation diagrams for cycloaddition reactions and electrocyclic reactions with 4n and 4n+2 π electrons, Cycloaddition of ketones, supra facial and antara facial cycloadditions. Secondary effects in [4+2] cycloaddition. Stereochemical effects on rate of cycloaddition reaction, Diels-Alder reaction, 1,3-dipolar cycloaddition, Click Chemistry (Azide–Alkyne Cycloaddition) Cheletropic reaction, the Nazarov reaction. 2s+2a cycloaddition of ketenes. **Paternò–Büchi Reaction** ([2+2] photocycloaddition),<br>**Sigmotropic Rearrangement**: Suprafacial and antarafacial shift involving H and carbon moieties, Retention and inversion of configuration, [3,3]-, [1,5]-, [2,3] and [5,5]- Sigma tropic rearrangements, Claisen rearrangements (including Aza-Claisen, Ireland-Claisen), Cope rearrangements (including Oxy-Cope, Aza-Cope), Sommelet-Hauser rearrangements, Group transfer reaction, Ene reaction. | **15** |
| **Unit II:** Photochemical Reaction | **Photochemistry:**<br>**Introduction to Photochemistry and Photophysical Processes:** Principles of photochemistry: quantum yield, electronic states and transitions, selection rules, modes of dissipation of energy (Jablonski diagram), electronic energy transfer: photosensitization and quenching process.<br>**Photochemical Reaction**: Photochemistry of carbonyl compounds: π→π*, n→π* transitions, | **15** |

| | | |
|---|---|---|
| | Norrish I and Norrish-II cleavages, Paterno-Buchi reaction. Photoreduction, calculation of quantum yield, photochemistry of enones, photochemical rearrangements of α, β unsaturated ketones and cyclohexadienones. Photo Fries rearrangement, Barton reaction. | |
| **Unit III: Photochemistry of olefins and Arenes** | **Photochemistry of olefins:** Cis-trans isomerization, dimerizations, hydrogen abstraction, addition and Di- π- methane rearrangement including aza-di- π -methane. Photochemical Cross-Coupling of Alkenes, Photodimerization of alkenes.<br>**Photochemistry of arenes:** 1, 2, 1, 3 and 1, 4 additions. Photocycloadditions of aromatic Rings. Singlet oxygen and photo-oxygenation reactions. Applications of photochemical reactions in organic synthesis and natural product synthesis.<br>**Case study 1:** Photochemistry of Natural Products having β, γ-unsaturated Ketone Group<br>**Case Study 2:** Dye-Sensitised Photooxygenations<br>**Case Study 3:** Chemistry of Vision<br>**Case Study 4:** Chemistry of Photography | **15** |

**Reading references:**


1. J. Singh. *Photochemistry and Pericyclic Reactions*. New Age International (P) Ltd., Publishers, New Delhi. 2009, 3rd Ed.
2. F. A. Carey; R. J. Sundberg. *Advanced Organic Chemistry: Part A – Structure and Mechanisms*. Springer, New York. 2008, 5th Ed.
3. K. K. Rohatgi-Mukherjee. *Fundamentals of Photochemistry*. New Age International, New Delhi. 2018, 3rd Ed.
4. R. B. Woodward; R. Hoffmann. *The Conservation of Orbital Symmetry*. Academic Press, New York. 2013, 1st Ed.
5. P. S. Kalsi. *Organic Reactions and Their Mechanisms*. New Age International, New Delhi. 2020, 3rd Ed.
6. W. Carruthers. *Modern Methods of Organic Synthesis*. Cambridge University Press, Cambridge. 2004, 4th Ed.
7. A. Lehr; B. Merchand. *Pericyclic Reactions: A Problem-Solving Approach*. Academic Press, London. 2015, Illustrated Ed.
8. J. Mohan. *Organic Spectroscopy: Principles and Applications*. Narosa Publishing House, New Delhi. 2009, 2nd Ed.

## CH5 104: SPECTROSCOPY II: ADVANCED NMR AND MOLECULAR SPECTROSCOPY (L-T-P-C: 3-0-0-3)

| **Program:** M. Sc. Chemistry | **Semester:** III |
|---|---|
| **Course code:** CH5 104 | **Course name:** SPECTROSCOPY II<br>ADVANCED NMR AND MOLECULAR SPECTROSCOPY |

| **Lecture (Hours)** | **Practical (Hours)** | **Credits** | **Total Hours** | **Evaluation Scheme** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Component** | **Exam** | **Max. Marks** | **Passing %** |
| 3 per week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Objectives:**

- Students will learn the basic Principles of NMR, $^{13}C$ NMR, Raman, and Mössbauer spectroscopy.
- Student will learn the Interpretation of first-order and second-order NMR spectra and methods for their simplification.
- The course will cover the analysis and structure elucidation of organic compounds using 2D NMR techniques.
- Students will learn the fundamentals and applications of rotational and vibrational Raman spectra and mössbauer spectroscopy in chemical analysis.

**Course Learning Outcomes:** At the end of this course, students will be able to

**CO 1:** Remember the basic concept of $^{1}H$ and $^{13}C$, Raman and Mossbauer spectroscopy

**CO 2:** Interpret the $^{1}H$ and $^{13}C$ NMR spectra for molecular structure determination.

**CO 3:** Apply the knowledge of advanced NMR for the structure elucidation of an organic compound.

**CO 4:** Analyze the $^{1}H$, $^{13}C$ NMR, Raman and Mossbauer Spectroscopy to obtain molecular and electronic structural information.

### Syllabus

| **Units** | **Content** | **Hours** |
|---|---|---|
| **Unit I:** Proton NMR Spectroscopy | **$^{1}H$ NMR Spectroscopy** -Pople notation and spin assignments; chemical shift equivalence and magnetic equivalence; Differences between first order and Second order effects, examples of AB, AX, A2X2, AX2, AA'XX', AMC and ABX systems,<br>**Simplification of second order spectrum:** selective decoupling, use of chemical shift reagents for stereochemical assignments, Proton exchange, Deuterium exchange, Nuclear Overhauser Effect (NOE); Differentiation of compounds/ isomers by PMR; To identify structure from PMR data, Study of dynamic processes by VT NMR, restricted rotation (DMF, DMA, biphenyls, annulenes), cyclohexane ring inversion, NMR applications in natural product and pharmaceutical structure elucidation. | **15** |
| **Unit II:** Carbon NMR Spectroscopy | **$^{13}C$ NMR Spectroscopy**- To identify structure from $^{13}C$ NMR data; Use of $^{13}C$ spectra in differentiating compounds/isomers; 2D NMR Spectroscopy Principles and applications of homonuclear and heteronuclear 2D NMR techniques (COSY); two-dimensional NMR spectroscopy. COSY, HMBC, HMQC, NOESY.<br>Editing techniques: INEPT and DEPT methods, Time scale- Multinuclear, Introduction to NMR of nuclei other than proton and carbon-**$^{19}F$ NMR, $^{31}P$ NMR, $^{15}N$ NMR, and $^{11}B$ NMR**. | **15** |
| **Unit III:** Raman and Mossbauer Spectroscopy | **Raman spectroscopy-** Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra, Raman activity of vibrations, Vibrational Raman spectra, polarization of light and Raman effect, applications., Mutual exclusion principle<br>**Mossbauer Spectroscopy:** Basic principles, spectral parameters and spectrum display. Isomer shift, quadrupole splitting, magnetic hyperfine splitting. Application of the technique to the studies of (1) bonding and structures of Fe+2 and Fe+3 compounds including those of intermediate spin, (2) Sn+2 and Sn+4 compounds- nature of M-L bond, structure and detection of oxidation state and in equivalent MB atoms.<br>Applications in nanomaterials, catalysts, and bioinorganic systems. | **15** |

**Reading references:**

1. R. M. Silverstein; G. C. Bassler; T. C. Morrill. *Spectrometric Identification of Organic Compounds*. John Wiley & Sons, New York. 1991, 5th Ed.
2. R. J. Abraham; J. Fisher; P. Loftus. *Introduction to NMR Spectroscopy*. Wiley, Chichester. 1992, 1st Ed.
3. J. R. Dyer. *Application of Spectroscopy of Organic Compounds*. Prentice Hall, Englewood Cliffs, N.J. 1965, 1st Ed.
4. D. H. Williams; I. Fleming. *Spectroscopic Methods in Organic Chemistry*. Tata McGraw-Hill, New Delhi. 1968, 7th Ed.
5. J. L. McHale. *Molecular Spectroscopy*. CRC Press, Boca Raton. 2017, 2nd Ed.
6. D. L. Pavia. *Introduction to Organic Spectroscopy*. Cengage India Pvt. Ltd., New Delhi. 2015, 5th Ed.
7. D. N. S. Narayana. *Handbook of Molecular Spectroscopy*. J. K. International Publishers, New Delhi. 2015, 1st Ed.
8. Y. R. Sharma. *Elementary Organic Spectroscopy*. S. Chand & Company Ltd., New Delhi. 2007, Revised Ed.
9. D. A. Skoog. *Principles of Instrumental Analysis*. Holt Saunders International Edition, New York. 2016, 7th Ed.
10. R. Kakkar. *Atomic and Molecular Spectroscopy*. Cambridge University Press, Cambridge. 2015, 1st Ed.

## CH5 105: SPECTROSCOPY ANALYSIS & DATA INTERPRETATION LABORATORY (L-T-P-C: 0-0-8-4)

| **Program:** M. Sc. Chemistry (Analytical) | **Semester:** III |
|---|---|
| **Course code:** CH5 105 | **Course name:** SPECTROSCOPY ANALYSIS & DATA INTERPRETATION LABORATORY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| - | 8 per week | 4 | 120 | Lab | CCE, ESE | 100 | 35 |

**Course Objectives:**

- The objective of the practical course is to make students understand the spectral analysis of various organic compounds which are synthesized in laboratory and chemical industries.
- Students will also learn various software used in analysis of data in NMR and IR spectroscopy.
- Students will learn structural prediction and confirmation of compounds through their spectral analysis.

**Course Learning Outcomes:** At the end of this course students will be able to

**CO 1:** Understand the analysis of $^{1}H$ and $^{13}C$-NMR spectra with analysis
**CO 2:** Explain the IR spectra analysis for functional group determination
**CO 3:** Apply the knowledge of spectral analysis in structural characterization
**CO 4:** Demonstrate the application of software for NMR analysis
**CO 5:** Demonstrate the knowledge of spectroscopy in analysis of drug molecules

### Syllabus

| S. No. | Name of Experiment | Hours |
|---|---|---|
| **1** | To learn Chem Draw, Chemsketch, ISIS Draw tools | **12** |
| **2** | To Draw the Structure of Simple aliphatic, aromatic, and heterocyclic compounds in ChemDraw with different substituents. Get the correct IUPAC Name and predict the 1H-NMR Spectra. | **12** |
| **3** | To learn sample preparation and data analysis of UV spectroscopy | **12** |
| **4** | To Determine the Effect of alkaline and acidic media on the organic compound using UV-Vis spectroscopy | **12** |
| **5** | To Determine the Bathochromic shift in Alkaline medium of p- Nitrophenol Compared to p-Nitrophenol. Determination of Hypsochromic shift in acidic medium of Aniline compared to Aniline. | **12** |
| **6** | Structure elucidation using 1H and 13C NMR spectra | **24** |
| **7** | To Learn Mestronova software for structure analysis | **12** |
| **8** | Solving structure elucidation problems using multiple spectroscopic data sheets (NMR, MS, IR, and UV-Vis) on at least 10 examples | **24** |

**Reading references:**


1. R. K. Bansal. *Practical Organic Chemistry*. New Age International Pvt. Ltd., New Delhi. 2008, 5th Ed.
2. D. Field; S. Sternhell; J. R. Kalman. *Organic Structures from Spectra*. John Wiley & Sons Ltd., Chichester. 2008, 4th Ed.
3. F. G. Mann; B. C. Saunders. *Practical Organic Chemistry*. Pearson Education India, New Delhi. 2009, 4th Ed.
4. W. Kemp. *Organic Spectroscopy*. Macmillan, London. 1994, 3rd Ed.
5. P. S. Kalsi. *Spectroscopy of Organic Compounds*. New Age International Pvt. Ltd., New Delhi. 2020, 8th Ed.
6. Y. R. Sharma. *Elementary Organic Spectroscopy – Principles and Chemical Applications*. S. Chand & Company Ltd., New Delhi. 1992, 5th E

## CH5 OR106: ADVANCED ORGANIC CHEMISTRY LAB (L-T-P-C: 0-0-8-4)

| **Program:** M. Sc. Chemistry (Organic) | **Semester:** III |
|---|---|
| **Course code:** CH5 OR106 | **Course name:** ADVANCED ORGANIC CHEMISTRY LAB |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| - | 8 per week | 4 | 120 | Lab | CCE, ESE | 100 | 35 |

**Course Description:**

- This is a practical course which deals with chemical synthesis of various compounds and materials which are synthesized in laboratory and chemical industries.
- This course also explains the various data analysis used in organic synthesis.

**Course Learning Outcomes:** At the end of this course students will be able to
**CLO1:** Understand the potentiometric analysis of chemical compounds
**CLO2:** Explain the use of pH meter in sample analysis of acid and base
**CLO3:** Apply the knowledge of conductometry in analysis of metal complexes
**CLO4:** Demonstrate the application of polarography and electrogravimetry

### Syllabus

| Sr. No. | Name of the Experiment | Hours |
|---|---|---|
| 1 | Lab orientation, TLC, melting point, Discussion ofv recrystallization techniques and Introduction of all types of glassware used and their handling<br>Detailed Discussion of all Characterisation Techniques used in Advanced Organic Lab for structural determination (UV-vis, TLC, IR, NMR (Review) | 8 |
| 2 | Safety protocols and MSDS preparation for common Organic Reagents Acids, Bases, Salts, Acid Chlorides e.g. SOCl2, fumming liquids like Br2, and Volatile liquids | 8 |
| 3 | 2-Phenyl indole (Fischer indole synthesis),<br>Benzilic acid from benzoin (Benzilic acid rearrangement) | 8 |
| 4 | 7-Hydroxy -3-methyl flavone (Baker-Venkatraman reaction),<br>Benzyl alcohol and benzoic acid from benzaldehyde (Cannizzaro reaction) | 8 |
| 5 | 4-Chlorotoluene from p-toluidine (Sandmeyer reaction)<br>Photochemical reaction: Synthesis of benzopinacol from benzophenone using Sunlight | 8 |
| 6 | Diels-Alder reaction: anthracene and maleic anhydride<br>Beckmann rearrangement: Acetanilide from Acetophenone Oxime | 8 |
| 7 | Vanillyl alcohol from vanillin ($NaBH_4$ reduction)<br>Stilbene from benzyl chloride (Wittig reaction) | 8 |
| 8 | Diphenyl methyl carbinol (Grignard reaction)<br>Cyclohexanol from cyclohexanone (LAH reduction) | 8 |
| 9 | Organometallic reactions: Palladium catalyzed cross-coupling reaction | 8 |
| 10 | Nitration: Preparation of 2,4-dinitroanisole from anisole,<br>(2) Acytatilation: purification of Acetanilide from aniline, | 8 |
| 11 | Halogination: Preparation of p-Bromo Acetanilide from Acetanilide,<br>(4) Coupling reaction: Synthesis of methyl orange, | 8 |
| 12 | Synthesis of 4-methyl-7-hydroxycoumarin from resorcinol and ethyl acetoacetate<br>**Click Chemistry**: Cu-catalyzed azide-alkyne cycloaddition | 8 |
| 13 | **Azo Coupling**: Methyl orange synthesis<br>**Addition-Elimination Reaction** (e.g., Schiff base from aldehyde & amine) | 8 |
| 14 | One-pot synthesis of β-amino carbonyl compounds from formaldehyde, amine, and ketone. | 8 |

| | | |
|---|---|---|
| **15** | Oxidation of alcohols to carbonyl compounds using selective reagents e.g. using Hypervalent Iodine (Dess–Martin Periodinane) | **8** |

**Reading references:**

1. F. G. Mann; B. C. Saunders. *Practical Organic Chemistry*. Pearson Education India, New Delhi. 2009, 4th Ed.
2. I. Vogel; B. S. Furniss. *Vogel's Textbook of Practical Organic Chemistry*. Longman Scientific & Technical, Essex. 1989, 5th Ed.
3. L. R. Shriner; C. K. Fuson; R. C. Hermann; T. C. Morrill; D. Y. Curtin. *The Systematic Identification of Organic Compounds*. John Wiley & Sons, New York. 2023, 9th Ed.
4. R. M. Silverstein; G. C. Bassler; T. C. Morrill. *Spectrometric Identification of Organic Compounds*. John Wiley & Sons, New York. 1991, 5th Ed.

## CH5 EOR1: MEDICINAL CHEMISTRY (L-T-P-C: 2-0-0-2)

| **Program:** M. Sc. Chemistry | **Semester:** III |
|---|---|
| **Course code:** CH5 EOR1 | **Course name:** MEDICINAL CHEMISTRY |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 8 per week | - | 2 | 30 | Lecture | CCE, ESE | 50 | 18 |

**Course Objectives:**

- To know various terminologies used in medicinal chemistry.
- To understand the development of drugs and process.
- To discuss anticancer drugs with their mode of action.
- To discuss the design and synthesis of anti-infective drugs such as anti-bacterial and antimalarial.

**Course Outcomes:** At the end of this course, students will be able to
**CO 1:** Explain process and steps in drug development
**CO 2:** Classify various diseases and their drugs with mode of action
**CO 3:** Apply the knowledge of QSAR in discovery of clinical candidates
**CO 4:** Analyze synthesis and mechanism of action of drugs
**CO 5:** Demonstrate the effects of drugs on human health and life

### Syllabus

| Units | Content | Hours |
|---|---|---|
| **Unit I: Drugs and Drug Design** | **Drugs:** Classification of drugs; drug targets; Lead discovery; Lead Modification and optimization; Pharmacophore; homologation; bioisostere; chain branching; Electronic effects; Lipophilicity; Structure-Activity Relationships; Quantitative-structure activity relationships (QSAR). Concepts of drug receptors, Elementary treatment of drug-receptor interactions and theories associated with it, Understanding of IC50, MIC, LD50, Concept of prodrugs and soft drugs, Bioisosterism, Drug metabolism, (ADMET) recognition of drug like properties. Software prediction for ADMET properties | **10** |
| **Unit II: Anticancer Drugs** | **Anti-cancer Drugs:** Introduction of cancer, classification of anticancer agents, therapeutic targets for anticancer drugs, role of alkylating agents in treatment of cancer, synthesis use and side effects antineoplastic agents: Mechlorethamine, cyclophosphamide, melphalan, mustards (mode of action) fluorouracil, 6-mercapto purine, Advance characterization of cancerous cells | **10** |
| **Unit III: Anti-infective Drugs** | **Anti-bacterial Drugs:** Introduction and general mode of action of anti-bacterial agents, Synthesis of sulphonamides, norfloxacin, Dapsone, amino salicylic acid, isoniazid, ethionamide, ethamutol.<br>Challenges and address of antimicrobial resistance<br>**Anti-malarial Drugs:** Introduction and life cycle of malarial parasites, Mode of action of antimalarial agents SAR of antimalarial agents, Synthesis of 4-amino and 8-amino quinoline, mefloquine chloroquine and primaquine.<br>AI in drug discovery | **10** |

**Reading references:**

1. A. Gringuage. *Introduction to Medicinal Chemistry: How Drugs Act and Why*. Wiley-VCH, Weinheim. 1996, 1st Ed.

2. Wilson; Gisvold. *Textbook of Organic Medicinal and Pharmaceutical Chemistry*. Lippincott Williams and Wilkins, Philadelphia. 2010, 12th Ed.
3. S. S. Pandeya; J. R. Dimmock. *An Introduction to Drug Design*. New Age International, New Delhi. 1997, 1st Ed.
4. D. J. Abraham. *Burger's Medicinal Chemistry and Drug Discovery, Vol. 1* (Chapters 9 and 14), Ed. M. E. Wolff. John Wiley & Sons, New York. 2003, 6th Ed.
5. L. L. Brunton; B. A. Hilal-Dandan; R. A. Knollmann (Eds.). *Goodman and Gilman's: The Pharmacological Basis of Therapeutics*. McGraw-Hill Education, New York. 2022, 14th Ed.
6. R. B. Silverman. *The Organic Chemistry of Drug Design and Drug Action*. Academic Press, San Diego. 2014, 3rd Ed.

## CH5 EOR4: INDUSTRIAL CHEMICAL METHOD AND ANALYSIS (L-T-P-C: 2-0-0-2)

| **Program:** M. Sc. Chemistry | **Semester:** III |
|---|---|
| **Course code:** CH5 EOR4 | **Course name:** INDUSTRIAL CHEMICAL METHOD AND ANALYSIS |

| **Lecture (Hours)** | **Practical (Hours)** | **Credits** | **Total Hours** | **Evaluation Scheme** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Component** | **Exam** | **Max. Marks** | **Passing %** |
| 2 per week | - | 2 | 30 | Lecture | CCE, ESE | 50 | 18 |

**Course Objectives:**

- To understand the various industrial chemical processes at pilot scale level.
- To identify chemical hazards and pollutants with their standard operating procedure.
- To understand regulatory guidelines of industrial processes.

**Course Learning Outcomes:** At the end of this course students will be able to
**CO 1:** Explain the material safety data sheet of chemical compounds
**CO 2:** Classify various hazardous chemicals and their handling
**CO 3:** Apply the knowledge in recovery and recycling of various industry chemicals
**CO 4:** Demonstrate the guidelines and process for setting up small-scale industry
**CO 5:** Evaluate the impact of chemicals on human health and life

### Syllabus

| **Units** | **Content** | **Hours** |
|---|---|---|
| **Unit I:** Toxic Chemicals Management | Industrial toxic and hazardous chemicals, Understanding of operating procedure for handling flammable or explosive chemicals Incineration of hazardous chemicals. Identification, classification and segregation of industrial toxic /hazardous chemicals, Recovery, recycling, and reuse of industrially important chemicals | **10** |
| **Unit II:** Small Scale Industry and R & D | Establishment of small- scale Industry, SSI rules and regulations, Registration, Licensing, Incentives, Factory act, Labor laws, FDA, export-import regulations, and tax benefits, Role of R and D, Functional structure of R&D Unit, Research strategies and manufacturing interface; Safety protocols | **10** |
| **Unit III:** Process Development and Scale-up | Principles of process development: lab to pilot scale; Batch vs. continuous processing: advantages, limitations, and design considerations; Unit operations in chemical industries: mixing, distillation, extraction, drying, and filtration. Process optimization: yield improvement, cost minimization, safety, and sustainability; Reaction engineering basics: heat and mass transfer in industrial reactions; Troubleshooting in scale-up: impurity handling; Case studies: scale-up of pharmaceutical intermediates with example of a drug as case. | **10** |

**Reading references:**

1. R. R. Mukherjee. *Elements of Quality Control*. Vani Educational Books, New Delhi. 1984, 1st Ed.
2. S. K. Tulsi. *Incentives for Small Scale Industries*. ESRS Publications, New Delhi. 1980, 1st Ed.

## SEMESTER IV

### SYLLABUS WITH CLO

### CH5 OR201: RESEARCH OR INDUSTRIAL PROJECT (L-T-P-C: 0-0-20-10)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** IV |
| **Course code:** CH5 OR201 | **Course name:** RESEARCH OR INDUSTRIAL PROJECT |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| - | 20 per week | 10 | 300 | Lab | CCE, ESE | 100 | 35 |

**Course Description:**

- This is a compulsory course performed in the final semester where the students get a semester-long exposure to research.
- Students who work on research and industrial projects gain valuable training and experience that can help them in their future careers.
- Students can work on real-world research projects proposed by industry or public sector sponsors.
- This course helps to train individuals who contribute to human resources required in the chemical/pharmaceutical industry. The research work may lead to academic research articles as well. They also learn about patents, scientific publications, and literature search tools

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Understand the real-world academic/industrial research problems
**CO 2:** Apply the knowledge gained during various theoretical and practical courses
**CO 3:** Design different projects with the knowledge of chemistry to solve existing problems in society
**CO 4:** Understand data interpretation and data analysis
**CO 5:** Learn to reboot any experimental problems.

**Syllabus:** Lab-specific research topics.

## CH5 OR202: PROJECT REPORT (L-T-P-C: 2-0-0-2)

| | |
|---|---|
| **Program:** M. Sc. Chemistry | **Semester:** IV |
| **Course code:** CH5 OR202 | **Course name:** PROJECT REPORT |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 2 per week | - | 2 | 30 | Lecture | CCE, ESE | 100 | 35 |

**Course Description:** In this course, the students learn to summarise their learning experiences.

- They learn the proper ways to write a 'project thesis'.
- This contains a comprehensive overview of a project's objectives, progress, team performance, and milestone accomplishments. It also gives an account of the challenges faced during a project's execution, solutions devised to tackle them, and the lessons learned during the process.
- They also learn about different communication medium like Microsoft word, chemdraw etc.

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Understand how to report a practical work into a thesis
**CO 2:** Learn to publish their research results after the program
**CO 3:** Learn the art of written scientific communications

**Syllabus:** Depends on the research performed in respective labs.

## CH5 OR203: PROJECT PRESENTATION (L-T-P-C: 3-0-0-3)

| **Program:** M. Sc. Chemistry | **Semester:** IV |
|---|---|
| **Course code:** CH5 OR203 | **Course name:** PROJECT PRESENTATION |

| Lecture (Hours) | Practical (Hours) | Credits | Total Hours | Evaluation Scheme | | | |
|---|---|---|---|---|---|---|---|
| | | | | Component | Exam | Max. Marks | Passing % |
| 3 per week | - | 3 | 45 | Lecture | CCE, ESE | 100 | 35 |

**Course Description:** In this course

- The students mainly learn to communicate their work performed to the audience.
- They learn to use different communication mediums (for example Microsoft PowerPoint) and convince their audience about the research findings.
- This course helps students to increase confidence, presence, and enjoyment of public speaking. The students also learn to use vocal techniques; use tone, range, articulation, power, pace, and pausing to make an impact.
- The students learn the use of body language and gestures to create credibility.

**Course Outcomes:** At the end of this course students will be able to
**CO 1:** Develop proper communication skills.
**CO 2:** Defend their accomplished research in front of experts.
**CO 3:** Gain confidence in facing job interviews.

**Syllabus:** Depends on the research performed in respective labs.

**~:The End:~**