**1.1.3 Courses having focus on employability/ entrepreneurship/ skill development offered by the University during the year**

| Color Index | |
|---|---|
| Employability | Yellow |
| Entrepreneurship | Green |
| Skill Development | Pink |

**M.Sc. CHEMISTRY**

**TWO-YEARS FULL-TIME PROGRAMME**

**(Four-Semester Course)**

LINGAYA'S VIDYAPEETH

choose to know

**CHOICE BASED**
**CREDIT SYSTEM**
**2020-22**

## Vision, Mission and Core Values of the Vidyapeeth

### VISION OF VIDYAPEETH

Traditionally believing that God is the Source of all Truth, Goodness and Beauty, Lingaya's Vidyapeeth, wishes to develop in students a wisdom that translates academic achievementsinto responsible citizenship, sincere professional service and a deep respect for life and beauty in God's Creation and Recreation.

### MISSION OF VIDYAPEETH

- To impart knowledge and skills in the field of Engineering/ Technology, Management, Education, Science & Arts and related areas;
- To dedicate itself for improvement of social and economic status and enhancement of the quality of life for all;
- To strive for maximizing human welfare through education;
- To produce effective knowledge workers, practitioners and educators who will be guided by vision, compassion, knowledge, discipline, discovery with deep respect for human values;
- To provide an individual engineering and other professional COURSE experience for each student;
- To develop critical thinking, analytical ability and creative skills;
- To supplement the curricula, team work, leadership, communication skills, project management, social concerns and ethics and
- To establish interaction with industries for Technology, Research & Development.

### *In line with above vision and mission statements, Lingaya's Vidyapeeth has the following special characteristics:*

- Lingaya's Vidyapeeth is an Institution for providing a student with opportunity for allround development and education with the aim of effective living as a good citizen.
- It has special strength in the field of Engineering and Technology with emphasis onpractice and problem solving skills.
- Its activities and course curriculum concentrate on design, self-COURSE and research, which are the unique features of the Vidyapeeth.
- The primarily value of knowledge and skill imparted by Lingaya's Vidyapeeth residesin its utility in creating an infrastructure for the physical welfare of the general public,in sustaining good health of individual and the community.
- Lingaya's Vidyapeeth facilitates and promotes creativity and critical thinking capabilities in its students.
- The education in Lingaya's Vidyapeeth enhances the inherent capacity of a studentwith honesty, courage and fairness.

**SCHOOL OF BASIC AND APPLIED SCIENCES LINGAYAS VIDYAPEETH**

## VISION OF SCHOOL

To be a School committed to promote Science and research exploration and education for attracting young talented students to contribute effectively in augmenting the national poolfor scientific development who are responsible citizens and sincere professionals with the deep knowledge.

## MISSION OF SCHOOL

1. To strive to maximize human welfare through the understanding the different phenomena of science with advance scientific development.
2. To develop and maintain state –of –the –art infrastructure and research facilities to enable create, apply and disseminate knowledge.
3. To create inter-disciplinary research environment and
4. To prepare students who are capable to take up their future educational and career challenges.

## Vision and Mission of Department of Chemistry

## School of Basic and Applied Sciences LV

## VISION OF DEPARTMENT

To be a department dedicated to promoting multidisciplinary chemical science and research activities, as well as education for interesting young brilliant students, in order to efficiently contribute to augmenting the local and national pool of responsible people and genuine professionals with deep expertise.

## MISSION OF DEPARTMENT

1. To encourage young minds and help them to explore their strengths in both theory and experimental work of chemical sciences
2. To prepare our graduate to understand the chemical analysis to apply in other disciplinary approach.
3. To explore applications of chemical sciences in engineering, medical sciences and engage in collaborative research in a multidisciplinary environment.
4. The Chemistry Department is dedicated to producing competitive and professional graduates in multi-area

## PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1. After completion of Chemistry program students will able to get exposed to strong theoretical and practical background in fundamental concepts.
PEO2: Graduates will be practitioners in their chosen field and will function in their profession with social awareness and responsibility
PEO3. Graduates will be successful in pursuing higher studies in their chosen field
PEO4. Graduates will pursue career paths in teachingor research

**Mapping of PEOs with Mission Statements**

| PEO Statements | Department Mission 1 | Department Mission 2 | Department Mission3 | Department Mission4 |
|---|---|---|---|---|
| **PEO1** | 3 | 2 | 1 | 1 |
| **PEO2** | 1 | 2 | 3 | 2 |
| **PEO3** | 2 | 3 | 2 | 1 |
| **PEO4** | 2 | 1 | 2 | 3 |

## PROGRAM OUTCOMES (PO'S)

PO-1: Identify and resolve complex scientific issues in national and local level.

PO-2:Analyze and interpret data using analytical instruments to investigate chemical problems.

PO3: To solve chemical problems, choose, plan, and implement suitable experiment techniques, as well as instrumentation handling.

PO-4:Recognize and use contextual multidisciplinary information to evaluate societal, health, safety, and global problem that are important to research practices.

PO-5:Adopt scientific ideas about environmental use and long-term sustainability.

PO6: Enhance skills for future employability through activities such as seminar, communication skills, industrial visit, and internship.

PO-7: Recall the chemistry courses that are available for competitive test.

PO8: The students attain sound knowledge in the areas of organic, inorganic, physical, pharmaceutical chemistry and material for pursing higher education and research.

**Mapping of Program Outcome with Program Educational Objectives**

| | PEO1 | PEO2 | PEO3 | PEO4 |
|---|---|---|---|---|
| PO1 | 1 | 2 | 1 | 2 |
| PO2 | 2 | 1 | 3 | 2 |
| PO3 | 2 | 1 | 3 | 1 |
| PO4 | 2 | 1 | 3 | 1 |
| PO5 | 1 | 1 | 1 | 3 |
| PO6 | 3 | 3 | 1 | 1 |
| PO7 | 2 | 3 | 1 | 1 |
| PO8 | 1 | 2 | 2 | 3 |

PSO1: Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.

PSO2: Apply advanced concepts of Inorganic, Organic, physical and analytical chemistry for the benefit of human being.

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**M.Sc. Chemistry Specialization in Organic Chemistry**
**(Two Year Programme)**

**M.Sc. 1st Semester**

| S.No. | Subject Code | Subject | L-T-P | Credits | Type of Course: CC,AECC,SEC,DSE,GE | Course focus on Employability/ entrepreneurship /Skill Development |
|---|---|---|---|---|---|---|
| 1. | MCH-111 | Organic Chemistry-I | 4-1-0 | 5 | CC | Course focus On Employability |
| 2. | MCH-112 | Physical Chemistry-I | 4-1-0 | 5 | CC | Course focus On Employability |
| 3. | MCH-120 | Inorganic Chemistry-I | 4-1-0 | 5 | CC | Course focus On Employability |
| 4. | MCH-161 | Organic Chemistry –I Lab | 0-0-4 | 2 | CC | Course focus On Employability |
| 5. | MCH-162 | Physical Chemistry-I Lab | 0-0-4 | 2 | CC | Course focus on Employability |
| 6. | MCH-170 | Inorganic Chemistry Lab-I | 0-0-4 | 2 | CC | Course focus On Employability |
| | | **Total** | | **21** | CC | Course focus On Employability |

**M.Sc. IInd Semester**

| S.No. | Subject Code | Subject | L-T-P | Credits | Type of Course: CC, AECC, SEC, DSE, GE | Course focus on Employability/ entrepreneurship /Skill Development |
|---|---|---|---|---|---|---|
| 1. | MCH-114 | Inorganic Chemistry-II | 4-1-0 | 5 | CC | Course focus on Employability |
| 2. | MCH-115 | Organic Chemistry-II | 4-1-0 | 5 | CC | Course focus On Employability |
| 3. | MCH-116 | Physical Chemistry-II | 4-1-0 | 5 | CC | Course focus on Employability |
| 4. | MCH-117 | Analytical Chemistry | 4-1-0 | 5 | CC | Course focus On Employability |
| 5. | MCH-164 | Inorganic Chemistry Lab-II | 0-0-4 | 2 | CC | Course focus on Employability |
| 6. | MCH-165 | Organic Chemistry Lab-II | 0-0-4 | 2 | CC | Course focus on Employability |
| 7. | MCH-166 | Physical Chemistry Lab-II | 0-0-4 | 2 | CC | Course focus on Employability |
| 8. | MCH-167 | Analytical Chemistry Lab-I | 0-0-4 | 2 | CC | Course focus on Employability |
| 9. | MCH-168 | Summer Project | 0-0-4 | 2 | CC | Course focus on Employability |
| | | **Total** | | **30** | | |

## M.Sc. III[rd] Semester

| S.No. | Subject Code | Subject | L-T-P | Credits | Type of Course: CC, AECC, SEC, DSE, GE | Course focus on Employability/ entrepreneurship /Skill Development |
|---|---|---|---|---|---|---|
| 1. | MCH-212 | Heterocyclic Compounds | 3-1-0 | 4 | CC | Course focus on Employability |
| 2. | MCH-213 | Physical Chemistry III | 3-1-0 | 4 | CC | Course focus on Employability |
| 3. | MCH-219 | Nuclear & Radioactive Chemistry | 4-1-0 | 5 | CC | Course focus on Employability |
| 4. | MCH-220 | Bio Inorganic & Environmental Chemistry | 4-1-0 | 5 | CC | Course focus on Employability |
| 5. | MCH-260 | Inorganic Chemistry-III Lab | 0-0-4 | 2 | CC | Course focus on Employability |
| 6. | MCH-261 | Organic Chemistry-III Lab | 0-0-4 | 2 | CC | Course focus on Employability |
| 7. | MCH-263 | Physical Chemistry-III Lab | 0-0-4 | 2 | CC | Course focus on Employability |
| | | **Total** | | **24** | | |

## M.Sc. 1V[th] Semester

| S. No. | Subject Code | Subject | L-T-P | Credits | Type of Course: CC, AECC, SEC, DSE, GE | Course focus on Employability/ entrepreneurship /Skill Development |
|---|---|---|---|---|---|---|
| 1. | MCH-221 | Disconnection Approach and Pericyclic Reactions | 3-1-0 | 4 | CC | Course focus on Employability |
| 2. | MCH-222 | Chemistry of Natural Products | 3-1-0 | 4 | CC | Course focus on Employability |
| 3. | MCH-223 | Spectroscopy in Organic Chemistry | 3-1-0 | 4 | CC | Course focus on Employability |
| 4. | MCH-224 | Green Chemistry | 3-1-0 | 4 | CC | Course focus on Employability |
| 5. | MCH-271 | Organic Chemistry Lab-IV | 0-0-4 | 2 | CC | Course focus on Employability |
| 6. | MCH-267 | Dissertation/ Major Project | 0-0-8 | 4 | CC | Course focus on Employability |
| | | **Total** | | **22** | | |

# Semester: I

## (2020-2021)

**INORGANIC CHEMISTRY-I: (MCH-120)**

**Course Objective:**

1. The learners should be able to analyse the mechanism of selected catalytic organic reactions from
2. Organometallic reaction mechanisms are thoroughly discussed with emphasis on ligand substitution, oxidative addition, reductive elimination, insertion and elimination reactions.
3. The application of organometallics in catalysis is highlighted with selected important industrial processes.

**Course Outcomes:**

1. Identify the structure and bonding aspects of simple organometallic compounds
2. Apply different electron counting rules to predict the shape/geometry of low and high nuclearity metal carbonyl clusters Identify the different types of organometallic reactions
3. Apply the above concepts to explain different catalytic reactions.
4. To know about the bioinorganic compounds, trace elements, and essential humanrequired compounds

**Unit-I Organometallic Chemistry:**

Basic concept of organometallic chemistry, Metal carbonyl, Phosphine's, alkenes, alkynes & allyl complexes. Hydride, carbenes ,carbynes, metallocene, metal arenes compresses.
Fluxonality in Organometallic compound.

**Unit-II Organometallic Chemistry:**

Homogeneous & Heterogeneous catalysis: Oxidative all & reductive elimination, Insertion reaction, Agostic Interaction, Hydroformylation, Zeigler Natta catalyst, Wilkinson catalyst, Syntheses gas. Monasto process &waker process, catalytic.

**Unit- III Inorganic Reaction mechanism:**

Mechanism of substitution reaction of tetrahedral, trigonal bipyramidal, square planar & octahedral complexes. Potential energy diagram. Factors affecting reactivity of square planercomplex. Trans effect & its application to synthesis of complexes.

**Unit-IV Molecular rearrangement Process:**

Electron transfer reaction: outer & inner sphere complexes formation & rearrangement, Nature of bridging ligands, fission of successor complex, two electron transfers, syntheses of coordination compounds using electron transfer reaction.

**Unit-V Bioinorganic Chemistry:**

Basic Introduction (Porphyrin Ring, metallo porphyrin ring) , oxygen transport & oxygen storage system (Hemoglobin, myoglobin, hamocyanin, Hemerythrin), Metalloeneyme- CAE , CP, LADH , Xanthine Oxidase, Tyrosine, Cytochrome –C, Cyt-P-450, Vitamin B-12), Coenzyme-12.Electron transfer protean, Fe-Sulphur protein, cytochrome.Metal storage & metal transfer system ferritin , transferrin.

**Reference Books:**


1. Principle of Bioinorganic chemistry – Lippard and Berg, Univ. Science Books,1994.
2. Bio-coordination chemistry – Fenton, Oxford chemistry primer,1995.
3. Bioinorganic chemistry: Inorganic perspective in the chemistry of Life, Kaimand Schwederski,1994.
4. Inorganic chemistry – Shriver, Atkins, and Langford, 1994.
5. Bioinorganic Chemistry – Bertini, Gray, Lippard and Valentine Viva books Pvt. Ltd.1998.


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | 1 | - | - | 3 | 1 | - | 2 | 3 | 1 | 2 |

## PRACTICAL INORGANIC CHEMISTRY-I: (MCH-170)

### Course Objectives:

**1.** Students will get acquainted with the unifying techniques of synthesis and characterization of inorganiccompounds.

### Course Outcomes:

1. The students have the detailed knowledge of synthesis of different inorganic compound
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of characterizing Organic compounds.

## Practical Description

1. Preparation of Hexaamminecobalt(lII)chloride

2. Synthesis of CHLOROPENTAAMMINECOBALT(III) CHLORIDE

3. Preparation of ChloropentaamminecobaIt (III) chloride

4. To determine the molar conductance of [Co(NH3)5]Cl3, and [Co(NH3)5Cl]Cl2 by measuring conductivity of thesecompounds.

5. To determine the number of chloride ions in the [Co(NH3)5]Cl3 and[Co(NH3)5Cl]Cl2.

6. Synthesis of trans-dichlorobis (ethylenediamine) cobalt (III)Chloride

7. Synthesis of cis-Dichlorobis(ethylenediamine)cobalt (III)Chloride

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |

## ORGANIC CHEMISTRY-I: (MCH-111)

### Course Objectives:

1. Differentiate chiral and achiral molecules.
2. Recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso-compounds.
3. Identify the stereocenters in a molecule and assign the configuration as R or S.
4. Know the relationship between enantiomers and their specific rotations.

### Course Outcomes:

1. Draw all the stereoisomers of organic compounds, and recognize diastereomers, enantiomers, meso compounds and centres of symmetry
2. Calculate optical purity and enantiomeric excess, Discuss the relative stability of conformational isomers of cyclohexanes and related compounds.
3. Recognise and discuss the stereoisomers of chiral compounds that do not contain a stereogenic carbon centre and assign the configuration of the stereoisomers.
4. To learn the involvement of reactive intermediates and understand their structure and reactivity through various organic reactions.

### Unit-1: Stereochemistry-I:

Molecular Symmetry and Chirality: Symmetry operations and elements, point groups and symmetry number, Stereoisomerism: classification, racemisation, molecules with one, two or more chiral centres, DL, RS and EZ nomenclature. Planar and axial chirality. Stereochemistry of allenes, spiranes, alkylidine cycloalkanes, adamantanes, catenanes, biphenyls(atropisomerism), bridged biphenyls and cyclophanes.

### Unit-2 Stereochemistry-II:

Topicity and prostereoisomerism: topicity of ligands and faces and their nomenclature, stereogenicity, pseudoasymmetry, stereogenic and prochiral centres.Simple chemical correlation of configurations with examples, quasiracemates Cyclostereoisomerism: configuration, conformation, stability of cyloheanes(mono, di and tri- substituted), cyclohexenes, cyclohexanones, halocyclohexanones. Asymmetry induction: Cram's, prelog's and Horeau's rules; Dynamic stereochemistry (acyclic and cyclic) Curtin-Hammett Principle, circular dichromism and cotton effect.

### Unit-3 Study of reactive intermediates-I:

Linear free energy relationships and their applications (Hammett equation and modifications) Carbocations: Classical and non-classical, NGP (Neighbouring group participation), ion- pairs, molecular rearrangements in acyclic, monocyclic and bicyclic systems, stability and reactivity of bridged-head carbocations.

**Unit-4 Carbanions:**

Generation, structure and stability, ambident ions and their general reactions; HSAB principle and its application Radicals: Generation, structure and stability and reactions, radical cations and anions.

**Unit-5 Carbenes:**

Formation and structure, reactions invovingcarbenes and carbenoids. Nitrenes: Formation, structure, reactions of nitrenes Nucleophilic aromatic substitution: Benzynes. SNAr and SRN1 mechanisms; Ipso effect.

**Reference Books:**


1. F. A. Carey and R. A. Sundberg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th edition, Springer, New York,2007.

2. W. Carruthers and I. Coldham, Modern methods of Organic Synthesis, First South Asian Edition 2005, Cambridge UniversityPress.

3. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley,2007.

4. I. Fleming, Frontier Orbitals and Organic Chemical Reactions, Wiley, London,1976.

5. S. Sankararaman, Pericyclic Reactions- A text Book, Wiley VCH,2005.


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | 2 | 2 | 1 | 1 | 1 |
| CO2 | 1 | 2 | 1 | - | - | 2 | 3 | 2 | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | 2 | 3 | 3 | 2 | 2 |
| CO4 | 2 | 2 | 2 | - | - | 2 | 3 | 3 | 2 | 2 |

## PRACTICAL ORGANIC CHEMISTRY-I: (MCH-161)

## Course Objectives:

1. Students will get acquainted with the unifying principles of spectroscopy.
2. Students will learn atomic absorption spectroscopy, its basic principle, instrumentation and applications.

## Course Outcomes:

1. Study detailed knowledge of analytical ore analysis of different element, quantitative organic compound analysis and also have the spectroscopic determination method.
2. Learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Capable of synthesizing Organic compounds.

## PRACTICAL DESCRIPTION

I) Qualitative analysis of mono and bifunctional compounds.

II) Small Scale organic synthesis using one of the followingreactions:

i) Acylationreaction

ii) Bromination and bromineaddition

iii) Diazotizationreactions

iv) Couplingreactions.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | 2 | 2 | 1 | 1 | 1 |
| CO2 | 1 | 2 | 1 | - | - | 2 | 3 | 2 | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | 2 | 3 | 3 | 2 | 2 |

## PHYSICAL CHEMISTRY-I: (MCH-112)

### Course Objectives:

**1.** Recognize the most significant and elementary solutions of Schrodinger equation in molecular quantum mechanics.

**2.** Differential equations, partial differential equations, series solutions and special functions, linear vector spaces, transformations of coordinate matrix, representation of operators, eigenvalue problem.

### Course Outcomes:

1. Know about the elementary principles of quantum mechanics with particle in 1D box.
2. You understand the electronic structure of atoms and their periodicity.
3. Know about the electronic structure of molecules and chemical bonding.
4. You have a basic understanding of chemical structure determination.

**Unit-I Quantum chemistry:**

Postulates of quantum mechanics, Linear and Hermition operator, Commutation of operators and uncertainty principles.Differential equations, partial differential equations, series solutions and special functions, linear vector spaces, transformations of coordinate matrix, representation of operators, eigenvalue problem, orthonormal sets Fourier and Laplace transforms.

**Unit-II-Some exactly soluble problems:**

Particle in a box and ring. Concept of degeneracy and Jahn-Teller distortion. Simple harmonic oscillator problem and its solution using series solutions or factorization method. Calculation of various average values using ladder operators and recursion relations of Hermitepolynomials. Angular momentum operators. Eigenvalues and eigenfunctions. Ladder operators. Rigid rotator and hydrogen atom: Complete solution. Radial distributions. Virial theorem.

**Unit-III-HMO method and its applications:**

π-Electron approximation, Huckel molecular orbital theory of conjugated systems, calculation of properties- delocalization energy, electron density, bond order, alternant and nonalternant hydrocarbons, pairingtheorem.

**Unit-IV-Approximate methods-I:**

First order time-independent perturbation theory for non degenerate states. Variation theorem and variational methods. Use of these methods illustrated with some examples (particle in a box with a finite barrier, anharmonic oscillator, approximate functions for particle in a box and hydrogen atom).

**Unit-V-Approximate methods-II:**

Ground and excited state of helium atom.Pauli's exclusion principle. Many-electron atoms. Concept of spin and determinantal wave functions.

**Reference Books:**


1. P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, Oxford University Press, Oxford, 2004. (Must for Quantum Chemistrybasics)
2. Quantum Chemistry by RKPrasad
3. Quantum Chemistry by Era Levine (For Advance Quantum Chemistry)
4. Introduction to Quantum Chemistry by Clifford Dykstra
5. Elementary Quantum Chemistry by Frank Pilar, Mineola, N.Y. Dover,2001
6. Quantum chemistry and spectroscopy by Thomas Engel, Pearson/Benjamin Cummings, 2006
7. Quantum chemistry: fundamentals to applications by Tamás Veszprémi, Kluwer Academic/Plenum,1999.
8. J. P. Lowe and K. Petersen, Quantum Chemistry, Elsevier Academic Press, MA,USA, 2006


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 3 | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 2 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | 2 | - | - | - | 3 | 2 | - | 2 |
| CO4 | - | 2 | 2 | | - | - | 2 | 2 | 2 | 2 |

## PRACTICAL PHYSICAL CHEMISTRY-I: (MCH-162)

**Course Objectives**

1. Students will get acquainted with the unifying principles of conductometry,potentiometry and chemical kinetics.

**Course Outcomes:**

1. The students have the detailed knowledge of analytical ore analysis of different element,
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

### PRACTICAL DESCRIPTION

**Chemical kinetics:**

1. Determine the specific rate constant for the acid catalysed hydrolysis of methyl acetate bythe initial rate method. Study the reaction at two different temperatures and calculate the thermodynamic parameters.
2. Study the saponification of ethyl acetate with sodium hydroxide volumetrically.

**Conductometry:**

1. Determine the cell constant of the given conductivity cell at room temperature and study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (aceticacid).
2. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration ofions
3. Determine the equivalent conductance, degree of dissociation and dissociation constant (Ka) of aceticacid.
4. Study the conductometric titration of acetic acid vs. sodiumhydroxide

**Potentiometry:**

1. Prepare and test Calomel electrode.
2. Titrate hydrochloric acid and sodium hydroxide potentiometrically.
3. Determine the dissociation constant of acetic acid potentiometrically.
4. Titrate oxalic acid and sodium hydroxide potentiometrically.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | 2 | 2 | 1 | 1 | 1 |
| CO2 | 1 | 2 | 1 | - | - | 2 | 3 | 2 | 1 | 2 |
| CO3 | 1 | 2 | 2 | - | - | 2 | 3 | 3 | 2 | 3 |

## SEMESTER II

## INORGANIC CHEMISTRY-II: (MCH-114)

### Course Objectives:

1. Apply the concept of linear combination of atomic orbitals to hybridization and directedbonding in polyatomic molecules.
2. Solve the real-world problem using advanced numerical programs through Gaussianorbitals.
3. Show that molecular symmetry operations form a group and can be characterized by fundamental representations of groups known as irreducible

### Course Outcomes:

1. Analyze point group theory to the study of electrical, optical and magnetic properties andselection rules for absorption.
2. Apply time independent perturbation theory to complex problems ofmolecular energy levels in the presence of external electric and magnetic fields.
3. Determine the symmetry operations of any small and medium-sized molecule.
4. Explain various symmetry elements and operations of different molecules

### Course A: Group Theory and its Applications:

Symmetry elements and symmetry operations, Groups, subgroups, classes and its characteristics, products, classes and application of symmetry operations.

Equivalent atoms, equivalent symmetry elements, relation between symmetry elements andoperations.

Point group classification along with the Optical activity and Dipole moment based applications.

Reducible and irreducible representations, position vector, base vector for representation, character table, Wave functions for irreducible representations (p- and d- block only), Correlation diagram, Russell-Saunders coupling, vibronic coupling, non-cetrosymmetric complexes.

Infrared and Raman spectroscopy, SALCs, Hybridization and its applications, LCAO.

### Course B: d- and f- block elements:

Russel Saunders state, Term and symbols, CFT and splitting in $T_d$, $D_{4h}$, $C_{4v}$ systems, Determination of $D_q$ and Racah parameters, Orgel and Tanabe sugano diagrams, electronic absorption spectra ( complex ions), Magnetic properties (Transition metal complexes) Structure and bonding in complexes containing π-acceptor ligands. Spectrochemical and nephelauxetic series.

### Reference Books:


1. D. M. P. Mingos and D. J. Wales; Introduction to Cluster Chemistry, Prentice Hall,1990.
2. N. N. Greenwood and E. A. Earnshaw; Chemistry of elements, Second Edition, Butterworth- Heinemann,1997.
3. T. P. Fehlner, J. F. Halet and J-Y. Saillard; Molecular Clusters: A Bridge to solid-state Chemistry, Cambridge University press,2007.
4. B. D. Gupta and A. J. Elias; Basic Organometallic Chemistry: Concepts, Synthesis, and Applications, Universities Press (India),2010.

5. D. M. P. Mingos, Essential Trends in Inorganic Chemistry, Oxford, University Press,1998.
6. C. E. Housecroft, Metal-Metal Bonded Carbonyl Dimers and Clusters, Oxford Chemistry Primers (44), Oxford, University Press,1996.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | 3 | - | - | - | - | 2 | 3 | 1 | 1 |
| CO2 | - | 2 | 1 | - | 1 | - | 3 | 2 | 1 | 2 |
| CO3 | - | 3 | - | - | 1 | - | 3 | 3 | 3 | 2 |
| CO4 | - | 3 | - | - | 1 | - | 3 | 3 | 3 | 2 |

## PRACTICAL INORGANIC CHEMISTRY-II: (MCH-164)

**Course Objectives**

1. The objective of this course is to get the knowledge of analysis of various mixture of inorganic salts.

**Course Outcomes:**

1. The students have the detailed knowledge of qualitative analysis of mixture of inorganicsalts,
2. Students will learn about the titration, volumetric analysis and chromatography.
3. Anayse the various inorganic mixtures.

### PRACTICAL DESCRIPTION

1. Qualitative analysis of mixtures of inorganic salts including rare earthsalts.
2. Quantitative analysis of mixtures of metal ions by complexometric titrations using masking and de masking agents.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | - | 2 | 2 | 1 | 1 | 1 |
| CO2 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 |
| CO3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 |

## ORGANIC CHEMISTRY-II: (MCH-115)

### Course Objectives:

1. The course aims to improve a student's understanding of fundamental organic reactions and to add further transformations and principles to their knowledge base.
2. They will encounter anion, radical, pericyclic and organometallic mediated processes, gaining new insights into the factors governing the mechanistic, stereo-chemical and region-chemical course of such reactions.
3. Throughout the course the usefulness of the chemistry discussed with be highlighted through applications.

### Course Outcomes:

1. Delineate the mechanistic and stereochemical course of some sophisticated cascade.
2. Can learn different reducing and other reagents with stereoselectivity
3. Can describe different approaches to the formation of carbanions, discuss their structures, stabilities/reactivities and applications in synthesis
4. Radical reactions and appreciate their value in target oriented synthesis.

### Course A: Organic Synthetic methodology:

Reduction Chemistry: Stereochemistry and selectivity of catalytic hydrogenation along with the mechanism, Applications of Lithium aluminium hydride, Sodium borohydride, sodium cyanohydride, alkoxy substituted LAH, DIBAL, diborane, diisoamylborane, thexyborane, 9-BBN as reducing agents, Homogeneous hydrogenation mechanism using Ru and Rh metal complexes along with its applications.

Oxidation Chemistry: Sharpless epoxidation, Applications of DDQ, $SeO_2$, $Tl(NO_3)_3$. Coupling Reactions with Pd(0) and Pd(II): Stille, Suzuki and Sonogashira coupling, Heckreaction and Negishicoupling.

Reductions: stereochemistry, stereoselection and mechanism of catalytic hydrogenation andmetal-liquid ammonia reactions.

### Course B: Spectroscopy:

**PMR**: Effect of external magnetic field on the spinning nucleus, precessional motion and frequency. Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effects. Integrals of protons, spin-spin coupling, magnitude of coupling constant. Chemical and magnetic equivalence, proton exchange, factors affecting the coupling-first and non-first order spectra. Simplification of complex spectra and NOE experiments. Applications of PMR in structural elucidation of simple and complex compounds.

**CMR**: Resolution and multiplicity of $^{13}C$ NMR. $^{1}H$-decoupling, noise decoupling, broad band decoupling, deuterium, fluorine and phosphorus coupling. NOE signal enhancement, off-resonance, proton decoupling, structure applications of CMR, DEPT and INEPT experiments. Introduction to 2D-NMR, COSY, HMQC and HETCORspectra.

**ESR**: Hyperfine splitting, g-values, ESR spectra of molecules.

**MASS**: Unit mass and molecular ions, Singly, doubly/multiple charged ions, metastable peak, base peak, isotopic mass peaks, Recognition of $M^+$ ion peak, Ionization methods (CI, EI and FAB), general fragmentation rules, fragmentation of various classes of organic

molecules, McLafferty rearrangement, ESI, APCI and MALDIetc.

**Reference Books:**


1. P. W. Atkins, Molecular Quantum Mechanics, 2nd edition, Oxford University Press,1983.

2. P. F. Bernath, Spectra of Atoms and Molecules, 2nd Edition, Oxford University Press, 2005.

3. E. B. Wilson, Jr., J. C. Decius and P. C. Cross, Molecular Vibrations: The Theoryof Infrared and Raman Spectra, Dover Publications, 1980.

4. W. Demtroder, Molecular Physics, Wiley-VCH,2005.

5. J. A. Weil and J. R. Bolton, (Eds), Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, Second Edition, Wiley Interscience, John Wiley & Sons, Inc., 2007.

6. A. E. Derome, Modern NMR Techniques for Chemistry Research, Pregamon,1987.

7. C. P. Slichter, Principles of Magnetic Resonance, Third Edition, Springer-Verlag,1990.

8. T. C. Farrar and E. D. Becker, Pulse and Fourier Transform NMR, Academic Press,New York,1971.


| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | 1 | 1 | 1 | - | 1 | 1 | - | 1 | 2 | 3 |

## PRACTICAL ORGANIC CHEMISTRY-II: (MCH-165)

## Course Objectives

1. The objective of this course is to understand the basic principle of organic synthesis.

## Course Outcomes:

1. Study about the different functional groups.
2. Learn the basic principle of qualitative analysis.
3. Synthesize the various organic compounds.

### PRACTICAL DESCRIPTION

I) Qualitative analysis of mono and bifunctional compounds.

II) Small Scale organic synthesis using one of the followingreactions:

i) Oxidation andreduction

ii) Condensations

iii) Diazotizationreactions

iv) Acylationreaction

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | - | 1 | - | 3 | - | 1 | 1 |
| CO3 | 2 | 1 | 1 | - | 1 | - | 2 | 1 | 1 | 1 |

## PHYSICAL CHEMISTRY-II: (MCH-116)

### Course Objectives:

1. The learners should be able to apply principles and laws of equilibrium thermodynamics to multicomponent systems.
2. Can use spectroscopic data to calculate thermodynamic properties of ideal gases, real gases, solids and metals using the principles and techniques of statistical thermodynamics.
3. The learners can to apply elementary laws of chemical kinetics and analyze reaction mechanisms and changes in transport properties of chemical reactions and collision processes.

### Course Outcomes:

1. Understand and calculate change in thermodynamic properties, equilibrium constants,partial molar quantities, chemical potential.
2. Apply phase rule and, draw phase diagrams for one, and two component systems, identifythe dependency of temperature and pressure on phase transitions.
3. Calculate the absolute value of thermodynamic quantities (U, H, S, A, G) and equilibriumconstant (K) from spectroscopic data.
4. Predict heat capacity (Cv, Cp) of an ideal gas of linear and non-linear molecules from thenumber of degrees of freedom, rotational and vibrational wave numbers.

### Course A:

Statistical mechanics, thermodynamics, kinetics and macromolecules statistical mechanicsand thermodynamics.

### Fundamentals:

Concept of distribution. Thermodynamic probability and most probable distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles and its importance in Chemistry. Types of statistics: Maxwell-Boltzmann. Thermodynamic probability (W) for the three types of statistics. Derivation of distribution laws (most probable distribution) for the three types of statistics. Lagrange's undetermined multipliers. Stirling's approximation, molecular partition function and its importance. Assembly partitionfunction.

### Application to ideal gases:

The molecular partition function and its factorization. Evaluation of translational, rotational and vibrational partition function of monatomic, diatomic and polyatomic gases. The electronic and nuclear partition functions. Calculation of thermodynamic properties of ideal gases in terms of partition function. Statistical definition of entropy. Third law of Thermodynamics, Residual entropy.

### Macromolecules:

Concepts of number average and mass molecular weights. Methods of determining molecular weights (osmometry, viscometry, sedimentation equilibrium methods). Distribution of chain lengths. Average end-to-end distance.

### Course B: Kinetics:

Theories of reaction rates: Collision theory. Potential energy surfaces (basic idea). Transition

state theory (both thermodynamic and statistical mechanics formulations). Theory of unimolecular reactions, Lindemann mechanism, Hinshelwood treatment, RRKM model(qualitative treatment).

**Solution kinetics:**

Factors affecting reaction rates in solution. Effect of solvent and ionic strength (primary salt effect) on the rate constant. Secondary salt effects.

**Electrochemistry:**

Solutions: Activity coefficients and ion-ion interactions. Physical significance of activity coefficients, mean activity coefficient of an electrolyte and its determination. Derivation ofDebye-Huckel theory of activity coefficients (both point ion size and finite ion size models).Excess functions.

**Reference Books:**

1. P. Atkins and J. Paula, Physical Chemistry, 10th Edition, Oxford University Press,Oxford 2014.
2. D. A. McQuarrie and J. D. Simon, Molecular Thermodynamics, University ScienceBooks, California2004

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 2 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 2 |

## PRACTICAL PHYSICAL CHEMISTRY-II: (MCH-166)

### Course Objectives

1. Students will get acquainted with the unifying principles of conductometry,potentiometry and chemical kinetics.

### Course Outcomes:

1. The students have the detailed knowledge of chemical kinetics and electrochemistry.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

## Practical Description

**Chemical kinetics:**

1. Compare the strength of hydrochloric acid and sulphuric acid studying the rate of hydrolysis of methylacetate.
2. Study the kinetics of iodination of acetone in the presence of acid by the initial rate method.

**Conductometry:**

1. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in commercial sample of sodaash.
2. Study the conductometric titration of acetic acid vs. ammoniumhydroxide
3. Study the conductometric titration of sodium acetate vs.HCl

**Potentiometry:**

1. Prepare and test Calomelelectrode.
2. Titrate a mixture of strong and weak acids (Hydrochloric and aceticacids)
3. Titrate a mixture of weak acid (acetic acid) and dibasic acid (oxalicacid)
4. Titrate a mixture of strong acid (hydrochloric acid) and dibasic acid (oxalic acid) versus sodiumhydroxide.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 2 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |

## ANALYTICAL CHEMISTRY-I (MCH-117)

### Course Objectives:

1. The learners should be able to apply the conceptual understanding of the principles and implementation modes of several analytical instruments to chemical systems.
2. To know that mixtures are composed of constituents which are not combined
3. To apply methods of distillation, sublimation, chromatography, filtration (including buchner filtration), evaporation, decantation, using magnetism, sieving and skimming toseparate mixtures.
4. To understand the terms filtrate, residue, filtration, sediment, decant, distil, distillate, chromatogram and solventfront.

### Course Outcomes:

1. Solve the problems based on various analytical concepts
2. Design experiments with improved sample preparation.
3. Understand new measurement procedures and tools, Quantify analytes with proper data handling and analysis.
4. Describe qualitatively and model quantitatively the operation and design of economically viable processes

**Course A: Introduction to analytical chemistry:**

Scope & objectives, Analytical chemistry and chemical analysis, Classification of analytical methods, Method selection, Sample processing, Steps in a quantitative analysis, Quantitative range (bispartite classification), Data organization, Analytical validations, Limit of detection and limit of quantitation, The tools of analytical chemistry and good lab practices.

**Errors in Chemical Analysis and Statistical Evaluation of Data:**

Systematic and random errors, Accuracy and precision, Ways of expressing accuracy and precision, Normal error curve and its equation, Propagation of error, Useful statistical test: test of significance, the F test, the student 't' test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least-square method for linear plots), statistics of sampling and detectionlimitevaluation.

**Course B: Separation Methods:**

**(a) Multiple liquid-liquidextraction:**

Countercurrent extraction, Craig's tube and Craig's apparatus, distribution of single solute, Gaussian treatment in describing distribution pattern of solute fraction in $r^{th}$ tube after n- transfers.

**(b) FractionalDistillation:**

Temperature composition diagram of a binary system, concept of theoretical plates, HETP, Bubble-cap distillation column and derivation of Fenske equation.

**(c) Chromatography:**

General description of Chromatography, Principle of chromatography, Classifications of

chromatography, Techniques of planar and column chromatography, Gas chromatography, High-performance liquid chromatography.

**Gas Chromatography:**

Introduction, principle of gas chromatography, instruments for gas-liquid chromatography, detectors:- thermal conductivity detector, flame ionization detector, electron capture detector and others, gas chromatographic columns and stationary phases, factors affecting the efficiency of the column, Van-Deemter equation, resolution, retention time and other basic parameters. Interpretation of gas chromatograms. Qualitative analysis, Kovats retention index(I), Quantitative analysis, measurement of peak area, response factor; Temperature programming in gas chromatography, Applications of gas chromatography.

**High Performance Liquid Chromatography (HPLC):**

Basic difference between HPLC and conventional liquid chromatography with respect to sample applications, packing materials and equipments, detectors. Advantages and applications.

**Reference Books:**


**1.** Wilson, Ian D.; Adlard, Edward R.; Cooke, Michael; et al., eds. (2000).

**2.** Encyclopediaof separation science. San Diego: Academic Press. ISBN978-0-12-226770-3

**3.** D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, 6th Edition, Brooks/Cole Cengage Course, Belmont, CA,2007

**4.** J. Wang, Analytical Electrochemistry, 3rd Edition, Wiley – VCH,2006

**5.** P.T. Kissinger and W. R. Heineman, Laboratory Techniques in Electroanalytical Chemistry, 2nd Edition, Marcel Dekker Inc.,1996.


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | - | 3 | 3 | - | - | 1 | 2 | 3 | 2 | 2 |

## PRACTICAL ANALYTICAL CHEMISTRY-I (MCH-167)

### Course Objectives:

1. Students will get acquainted with the analytical techniques of and characterization of inorganic compounds.

### Course Outcomes:

1. The students have the detailed knowledge of synthesis of different inorganic compound
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of characterizing Inorganic compounds.

### Practical Description

1. Determination of accuracy, precision, mean deviation, standard deviation, coefficient of variation, normal error curve and least square fitting of certain set of experimental data in an analysis.
2. Composition of two sets of results in terms of significance (Precision and accuracy) by (I) student's t-test, (ii)F-test.
3. Determination of Fe (III) by chloride extraction inether.
4. Determination of Fe (III) as the 8-hydroxy quinolate (oxinate) by extraction inchloroform.
5. Separation of $Cd^{+2}$ and $Zn^{+2}$ quantitativelythrough an anion exchanger.
6. Separation of nickel, manganese, cobalt and zinc and determination of $R_f$values by thin layer or paper striptechniques.
7. Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and backtitration).

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 2 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |

## SEMESTER-III

## HETEROCYCLIC COMPOUNDS (MCH-212)

### Course Objectives:

1. Rationalization of the reactivity of heteroaromatic compounds.
2. Knowledge of methods to prepare some heterocyclic compounds with Five and Six members, fused rings and heterocyclic compounds two or more heteroatom's.
3. Improving the students' knowledge of the methods of preparation followed by the Reaction Mechanism.
4. Application for the Synthesis and Design of some biologically active compounds derivedfrom heterocyclic compounds.

### Course Outcomes:

1. Be familiar with the structures of important classes of heterocyclic aromatic organic compounds.
2. Classify simple heterocyclic aromatic compounds as electron deficient or electronrich and explain their reactivity based on these properties.
3. Know how selected organometallic reactions can be applied in heterocyclic chemistry.
4. Explain on a mechanistic level, reactions and synthesis of important electrondeficient nitrogen containing heterocycles.

**Unit-I Introduction toheterocycles:**

Nomenclature, spectral characteristics, reactivity and aromaticity

**Unit-II Synthesis and reactions of three and four membered heterocycles**:

Aziridine, azirine, azetidine, oxiranes, thiarines, oxetanes and thietanes.

**Unit-III Five-membered rings with two heteroatoms**:

pyrazole, imidazole, oxazole, thiazole, isothiazole, benzofused analogs.

**Unit-IV Chemistry of bicyclic compounds containing one or more heteroatoms.**

Bezofused six membered rings with one, two and three heteroatoms: benzopyrans, quinolones, isoquinolines, quinoxazalines, acridines, phenoxazines, phenothiazines, benzotriazines,pteridines.

**Unit-V Seven and large membered heterocycles:**

azepines, oxepines, thiepines. Chemistry of porphyrins and spiro heterocycles.

**Recommended Texts:**

1. "Heterocyclic Chemistry" by J A Joule and KMills
2. "Name Reactions in Heterocyclic Chemistry" by Jie JackLi
3. "Advances in Heterocyclic Chemistry" by Alan RKatritzky
4. "Synthesis of some heterocyclic compounds by advanced techniques" by Sandip Sadaphal

and MurlidharShingare
5. “Heterocyclic Chemistry” by Raj KBansal
6. “Heterocyclic Chemistry” byGILCHRIST
7. “HETEROCYCLIC CHEMISTRY” by Ahluwalia VK
8. “Heterocyclic Chemistry” by John A Joule and KeithMills

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | 1 | - | - | 2 | 1 | 1 | 1 | 2 | 2 | 2 |

**Organic Chemistry –III Practical: (MCH-261)**

## Course Objectives:

1. Students will get acquainted with the unifying principles of spectroscopy.
2. Students will learn atomic absorption spectroscopy, its basic principle, instrumentation and applications.

## Course Outcomes:

1. The students have the detailed knowledge of analytical ore analysis of different element, quantitativeorganic compound analysis and also have the spectroscopic determination method.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of synthesizing Organic compounds.

### PRACTICAL DESCRIPTION

1. QualitativeAnalysis:

   a) Less common metal ions- Tl, Se, Te, Mo, W, Ti, Zr, U&V

   b) Insolubles- Oxides($WO_3$, Silica, Alumina); Sulphates( Lead Sulphate, Barium Sulphate Strontium Sulphate and Calcium Sulphate);

   Halides(Calcium fluoride and silver halides)

   (2 less common metal ions and 1 insoluble to be given)

2. QuantitativeAnalysis:

   a) Separation and determination of two metal ions such as Ag- Cu, Cu- Ni, Cu- Zn, Ni- Zn, Cu-Fe etc. involving volumetric and gravimetric methods.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | 1 | - | - | 2 | 2 | 1 | 1 |

**PHYSICAL CHEMISTRY-III (MCH-213)**

## Course objectives:

1. Student is able to determine the (most important) quantum states of a given material (atoms, small molecules).
2. Student is able to determine which quantum state(s) belong(s) to the ground state.
3. Student can rationalize which transitions between quantum states as a result of an absorption, emission or scattering event have a more than zero probability of taking place.

## Course Outcomes:

1. Discuss the basics of Spetroscopy.
2. Study the principles of NMR, UV, Raman and Mass spectroscopy.
3. Able to characterize and interpret various organic compounds through IR NMR spectroscopy,.
4. Explain about elemental analysis technique, working basic and using of elemental analysis device.

### Unit I-Rotational spectroscopy:

Introduction to molecular spectroscopy, Rotational spectroscopy of diatomic molecules based on rigid rotator approximation, Determination of bond lengths and/ or atomic masses from microwave data, effect of isotopic substitution, non-rigid rotator, classification of polyatomic molecules, energy levels and spectra of symmetric top molecules and asymmetric top molecules, First order Stark effect.

### Unit II-Vibrational spectroscopy:

Normal coordinate analysis of mononuclear and heteronuclear diatomic molecules, Extension to polyatomic linear molecules, Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation, Force constants and amplitudes, Anharmonic oscillator, Overtones and combination bands, Dissociation energies from vibrational data, Vibration- rotation spectra, P, Q and R branches, Breakdown of the Born-Oppenheimer approximation,Nuclear spin effect.

### Unit III-Raman Spectroscopy:

Stokes and anti-stokes lines, Polarizability ellipsoids, Rotational and Vibrational Raman spectroscopy. Selection rules, Polarization of Raman lines.

### Unit IV-Atomic Spectra:

**(i)** Characterization of atomic states, Microstate and spin factoring methods, Hund's rules,Derivation of spin and orbital selection rules ( based on recursion relations of Legendre polynomials), spectra of complex atoms. Zeeman and Stark effect, Atomic photoelectronspectroscopy.

**(ii) Electronic spectroscopy:** Diatomic molecules, Selection rules. Breakdown of selection rules, Franck-Condon factors, Dissociation energies, Photoelectron spectroscopy ofdiatomic ($N_2$) and simple polyatomic molecules ($H_2O$, formaldehyde), Adiabatic and vertical ionization energies, Koopmans'theorem.

**Unit V-NMR spectroscopy:**

Larmor precession. Mechanism of spin-spin and spin-lattice relaxation and quantitative treatment of relaxation, Quantum mechanical treatment of the AB system, Selection rules and relative intensities of lines.

**Recommended Texts books:**


1. Hollas. J.M Modern Spectroscopy 4th Ed. Wiley &Sons(2004)
2. Barrow. G. M. introduction to Molecular Spectroscopy Mc Graw-Hill(1962)
3. Brand. J.C.D. & Speakman. J.C. Molecular Structure the Physical Approach 2nd Ed. Edward Arnold London(1975)
4. Chang. R. Basic Principles of Spectroscopy McGraw- Hall. New York, N.Y.(1970)
5. Moore, W.J. Physical Chemistry 4th Ed. Prentice-Hall(1972)
6. Warren, B.E. X-Ray Diffraction Dover Publications(1990)


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | 2 | - | - | - | 2 | 2 | 2 | 2 |
| CO4 | - | 1 | 1 | 1 | - | 1 | 2 | 2 | 1 | 2 |

## PRACTICAL PHYSICAL CHEMISTRY-III: (MCH-263)

### Course Objectives

1. Students will get acquainted with the unifying principles of conductometry,potentiometry and chemical kinetics.

### Course Outcomes:

1. The students have the detailed knowledge of chemical kinetics and electrochemistry.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

## Practical Description

1. Titrate a moderately strong acid (salicylic/mandelic acid) by the
(a) Salt-line method
(b) Double alkali method

2. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with sodium hydroxide.
3. Titrate a tribasic acid (phosphoric acid) against NaOH and Ba(OH)2 conductometrically.
4. Titrate

(i) Magnesium sulphate against BaCl2 and its reversetitration
(ii) HCl Vs NH4OH
(iii) Sodium oxalate Vs HCl

5. Estimate the concentration of each component of a mixture of AgNO3 and HNO3 byconductometric titration against NaOH.
6. Determine the degree of hydrolysis of aniline hydrochloride.
7. Determine the critical micelle concentration of a surfactant (sodium lauryl sulphate) by the conductivity method.
8. Study the effect of dielectric constant on the nature of the conductometric titration between maleic acid and sodium methoxide using different mixtures of benzene and methanol as solvents.
9. Determine the velocity constant for the saponification of ethyl acetate conductometrically.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 1 | 1 | 1 | 1 | - | 2 | - | 1 | 1 |
| CO3 | 1 | 2 | 1 | - | - | - | 2 | 1 | 2 | 2 |

# Nuclear & Radio Chemistry (MCH-219)

## Course Objectives:

1. Improve their knowledge of the basic information of Radiation and Nuclear chemistry; requirements, methods of preparation, uses of radio-elements series, nuclear models, nuclear properties, Mass energy, relationships, nuclear reactions, rates of radioactive decay, interaction of radiation with matter.
2. Improve their knowledge of instrumentation and Introduction to health – physical applications in nuclear and radiochemistry.

## Course Outcomes:

1. Know the significance of Radio Chemical Techniques
2. Apply the basic principle and methodology of Radio Chemical Techniques
3. Understand the applications of Radio Chemical Techniques.
4. Analyze and calculate the half life and decay rates of various radioactive elements

### Section-A:

**Nuclear Binding Energy:**
Justifications and applications; nuclear stability rules and decay of unstable nuclei. Nuclear Structure: Nuclear force, Liquid drop model, shell model andcollective mode.

### Section-B:

**Interaction of Radiation with matter**

Physical and chemical effects of radiation on matter (photoelectric effect, Compton effectand pair production).

**Radiochemical Techniques:**

**NAA:**Principle, Application and Limitation

**IDA:** Principle, Application and Limitation, Radiometric titrations.

### Section-C:

**Detection of Nuclear Radiation:**
Various methods of detecting nuclear radiations, Gas-filled counters –Ionization chamber;Proportional counter and G.M. counters, Scintillation detectors; Solid state detectors.

### Section-D:

**Nuclear Reactions**:
Energetics of nuclear reactions; various types of nuclear reactions including photonuclear, thermonuclear and spallation reactions; mechanism of nuclear reaction by compound nucleus model.

**Nuclear fission:**
Fission probability; energy release; theories of fission.

**Nuclear Fussion:**
Brief idea about breeder reactors,; accelerators and cyclotron.

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | 3 | 2 | 2 | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |

# Bioinorganic & Environmental Chemistry (MCH-220)

## Course Objectives:

1. Students will demonstrate the ability to plan and execute experiments that demonstrate the use and understanding of modern instrumentsand appropriate use of Bioinorganic Chemistry.
2. Students will demonstrate their ability to communicate effectively about environmental chemistry, demonstrating the ability to create an awareness about environment.
3. Students will develop a sense of community responsibility by becoming aware of scientific issues in the larger social on text.

## Course Outcomes:

1. Acquire broad knowledge of the field of Environmental Chemistry including basic principles, target organ toxicity and the toxicity of a select group of chemical compounds.
2. Use technical and analytical skills to quantify the level and effects of Bioinorganic Chemistry.
3. Understand relationships between chemical exposure and effects on physiologicalsystem
4. Design strategies for study of harmful effects of different pollutants.

## Section-A:

### Metal Ions in Biological Systems:

General survey of essential and trace metals, Disturbing factors in metabolicprocess and causes of diseases, different classes of drugs.

### Alkali and alkaline earth metals in biological systems:

Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, bloodclotting and hormones.

### Interaction of metal ions with Nucleotides:

metal ions in nucleotide systems, effect of metal ions on nuclei acids.

## Section-B:

Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier modelsystems.

Nitrogen fixation**:**

Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-$N_2$complexes, photosynthesis and chlorophyll.

### Metal transport and storage:

Transferrin, Ferritin, Siderophores

## Section-C:

### Environmental Chemistry:

Atmosphere: Chemical composition of atmosphere, atmospheric structure, Earth's radiation balance; oxides of N,C,S and their effects, Green house effect, acid rain, photochemical smog , air quality standards, depletion of ozone, particulate matter in atmosphere ,mechanism of aerosol formation in air, Noise pollution and their health hazards.

**Reference Books:**


1. "Advances in Inorganic Biochemistry: Metal Ions in Genetic InformationTransfer v. 3" by Luigi G Marzilli and Gunther L Eichhorn.
2. "Mechanisms of Metallocenter Assembly (Advances in inorganic biochemistry)" by Luigi G Marzilli and Gunther LEichhorn.
3. "Molecular Design in Inorganic Biochemistry (Structure and Bonding)" by Daniel Rabinovich.
4. "Fundamental Concepts of Environmental Chemistry" by G S Sodhi, Narosa Book Distributors PvtLimited.
5. "Environmental Chemistry" by Anil Kumar De, NEW AGE; 7Edition.


| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | 2 | 3 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 2 | - | 3 | - | 1 | 2 |
| CO3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 |
| CO4 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 |

**Inorganic Chemistry –III Practical: (MCH-260)**

## Course Objectives

1. Students will get acquainted with the unifying principles of synthesis and characterizationof metal complexes.

## Course Outcomes:

1. The students have the detailed knowledge of chemical kinetics and electrochemistry.
2. Students will learn error analysis, statistical data analysis, volumetric analysis, chromatography, flame photometry.
3. Students will be capable of understanding the principle of potentiometry and conductometry.

## Practical Description

Preparation of selected Inorganic compounds/complexes and their characterization using techniques/methods such as elemental analysis, conductance measurement, molecular weight determination, magnetic susceptibility measurements, infrared, UV, visible, Mossbauer and ESR spectra etc. Handling of air and moisture sensitive compounds.

i) Chromous Acetate
ii) $Hg[Co(SCN)_4]$
iii) $Ni(dmg)_2$
iv) $[Cu(NH_3)_4]SO_4.H_2O$
v) $[Ni(NH_3)_6]Cl_2$
vi) $K_3[Fe(C_2O_4)_3]$
vii) $VO(acac)_2$
viii) $Mn(acac)_3$
ix) Prussianblue
x) $[Co(NH_3)_5Cl]Cl_2$; $[Co(NH_3)_5NO_2]Cl_2$ ;$[Co(NH_3)_5ONO]Cl_2$
xi) $K_3[Al(C_2O_4)_3]$
xii) $[Ni(en)_3]S_2O_3$etc.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | 2 | 3 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 2 | 2 | - | 3 | - | 1 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |

## SEMESTER-IV

## DISCONNECTION APPROACH AND PERICYCLIC REACTIONS (MCH-221)

### Course Objectives:

1. To provide an introduction to the disconnection approach and synthesis of complex organic molecules.
2. Cover the core topics such as Transformations for C-X and C-C disconnection, functional group reactivity, chemo-selectivity, regio-selectivity and the strategy of multistep synthesis.
3. To introduce the classification and various type of Pericyclic reactions in Allylic andene.

### Course Outcomes:

At the end of the course,

1. Learn about the basic concepts of retro-synthesis of organic molecules.
2. Know about the starting material of end-products in chemicals reactions.
3. Apply the protection/deprotection of various functional group in organicsynthesis.
4. Discuss the applications of disconnection approach to various molecules (pharmaceutical and Industrial products.
5. To know about the various types of Pericyclic reactions and their applications in chemical reactions.

**UNIT-1 Carbon – Halogen (C-X) Disconnection**

Basic concept of disconnections, Strategy of C-X Disconnection, one group C-X Disconnection, two group C-X Disconnection, synthesis of amines by using C-X Disconnection, Study of some chemical reactions using C-X Disconnection

**UNIT-2Carbon – Carbon (C-C) Disconnection**

Study of some chemical reactions using C-C Disconnection, one group and α- carbonyl C-C Disconnection, generation of enolates, chemo selectivity, regio-selectivity, stereo selectivity and kinetics of enolate formation, chemical reactions of enolates.

**UNIT-3Protecting groups in organic synthesis**

What is a protecting group? Qualities of a good protecting group in organic synthesis. Protecting groups for Alcohols, Carbonyl (Aldehydes and Ketones), Carboxylic Acids andAmino groups.

**UNIT-4Pericyclic Reactions I**

Molecular orbital symmetry, Frontier orbitals of ethylene,1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclicreactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reaction.

**UNIT-5 Pericyclic Reactions II**

Conrotatory and disrotatory motions 4n, 4n+2 and allylsystems. Cycloaddition; antarafacial and suprafacial, [2+2] and [4+2] cycloaddition reaction, cycloaddition of ketones and cheleotropic reactions.Sigmatropic Rearrangements; suprafacial and antarafacial shiftinvolving H and carbon-moieties 3,3- and 5,5- sigmatropic rearrangements,Claisen, Cope and Aza-Cope rearrangements. Ene reaction.

**TEXT BOOKS/REFERENCE BOOKS:**

1. Organic Synthesis: The Disconnection Approach, S. Warren,2nd Edition, Wiley, 2008.
2. Reactions, Rearrangements and Reagents, S. N. Sanyal, bharatibhawan pub.& dis-newdelhi, 2014.
3. Advanced Organic Chemistry Part B, F.A. Carey and R.J. Sundberg, 5th Edition,Springer, 2008.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 3 |

## CHEMISTRY OF NATURAL PRODUCTS (MCH-222)

**Course Objectives:**

1. The course provides a brief introduction to plant systematic.
2. Significant poisonous and medicinal plants, together with natural medicines, will be discussed.
3. Important classes of compounds in and from nature will be emphasized, and stress will beput on classification, nomenclature, structure, biosynthesis of pharmaceutical perspectives.

**Course Outcomes:**

After completing the course the student will be able to:

1. Provide an overview of the field of natural product chemistry.
2. Identify different types of natural products, their occurrence, structure and properties.
3. Understand the working of DNA, RNA and plant pigments in Human body andplants respectively.
4. Explain the structure, synthesis and function of Steroids.

**UNIT-1 Alkaloids**

Introduction, occurrence, nomenclature, physiological actions, isolation, methods of structural determination. Synthesis of the following alkaloids: Atropine, Coniine. Ephedrine, Morphine, Nicotine and Quinine.

**UNIT-2 Terpenoids and Carotenoids**

Introduction, occurrence, classification, nomenclature, isolation, isoprene rule, methods ofstructural determination.

Synthesis of the following molecules: β-Carotene, Citral, Phytol, Terpeneol andZingiberene.

**UNIT-3 Plants Pigments**

Introduction, occurrence, nomenclature, isolation, methods of structural determination, synthesis of Apigenin, Cyanidin, Cyanidin-7-Arabinoside, Daidzein,Luteolin, Myrcetin, Quercetin, Quercetin-3-Glucoside and vitexin.

**UNIT-4 Steroids**

Introduction, occurrence, nomenclature, isolation, basic skeleton, Dicl's hydrocarbon and stereochemistry, methods of structural determination of Cholesterol. Synthesis of the following steroids: Aldosterone, Androsterone, Cholesterol, Estrone, Progesterone and Testosterone.

**UNIT-5Nucleic Acids**

Introduction, structures and functions of DNA and RNAs (m-RNA, t-RNA, r-RNA),Chemical and enzymatic hydrolysis of DNA and RNAs, an overview of gene expression (replication, transcription and translation), genetic code (origin, Wobble hypothesis), genetic errors, mutation and carcinogenesis and recombinant DNA technology.

**TEXT BOOKS/REFERENCE BOOKS:**

1. I.L. Finar, Organic chemistry, Vol. II, ELBS Publications, UK.
2. J. Mann, R.S. Devison, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Natural products chemistry and biological significance, Longman Publisher, Essex, UK.
3. Stereo selective Synthesis: A Practical Approach, M. Nogradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed.S. Coffey, Elsevier.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | 2 | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | -2 | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | 2 | - | - | 3 | 2 | - | 2 |
| CO4 | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 |

## SPECTROSCOPY IN ORGANIC CHEMISTRY (MCH-223)

### Course Objectives:

1. Explain what it means to use spectroscopic methods for qualitative and quantitative analysis.
2. To know about various electronic transitions occurs in ultra violet spectroscopy.
3. Students will learn about methods of analysis of functional groups in IR spectroscopy.
4. Structure identification by NMR spectroscopy and mass spectra of different organic compounds.

### Course Outcomes:

1. Explain the concepts of emission and absorption.
2. Identify the electromagnetic spectrum and its components.
3. Understand the importance of mass spectra in organic compound structuredetermination.
4. Apply the various spectroscopic techniques for evaluation of structureand position of functional group of organic molecules.

**UNIT-1 :Ultraviolet and Visible Spectroscopy**

Various electronic transitions (185-800nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

**UNIT-2:Infrared Spectroscopy**

Instrumentation and sample handling.Characteristic vibration frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines.Detailed study of vibration 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.

**UNIT-3:Nuclear Magnetic Resonance Spectroscopy**

General introduction and definition, chemical shift, spin-spin interaction, shielding &deshielding effects, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides &mercapto), complex spin-spin interaction between two, three, four and five nuclei (first order spectra), vicinal coupling, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE), 2D-NMR spectroscopy-COSY, NOESY techniques.

**UNIT-4:Mass Spectroscopy**

Principle of mass spectroscopy (instrument, operation and representation of spectra), mass spectrometer, interpretation of mass spectra, fragmentation pattern, mode of fragmentation, nitrogen rule, effect of isotopes, signals of doubly charged ion, applications viz; identification of substances, determination of molecular weight and molecular formula.

**TEXTBOOKS/REFERENCE BOOKS:**

1. Modern Spectroscopy, J.M.Hollas, John Wiley.
2. Applied Electron Spectroscopy for Chemical Analysis Ed. H.Windalwl and F.L.Ho.WileyInsterscience.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V.Parish, Ellis Harwood.;
4. Physical Methods in Chemistry, R.S. Drago, Saunders College.
5. Chemical Applications of Group Theory, F.A.Cotton.
6. Introduction to Molecular Spectroscopy, G.M. Barrow. McGraw Hill.
7. Basic principles of spectroscopy, R.Chang. McGarw Hill.

8. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M.Orchin, IBH-Oxford.
9. Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley.
10. Introduction to Magnetic Resonance, A, Carrington and A.D. Maclachalan, Harper & Row

| POs<br>Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 2 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | - | 1 | 2 | - | - | - | 2 | 3 | 2 | 3 |

**GREEN CHEMISTRY (MCH-224)**

## Course Objectives:

1. The primary objective of this course is to make students aware of how chemical processes can be designed, developed and run in a sustainable way.
2. Student will acquire the competence to think of chemistry as a sustainable activity. To give information about the design competitive chemical products and processes that attain the highest level of the pollution-prevention hierarchy by reducing pollution atits source**.**

## Course Outcomes:

1. Learn the basic principles of green and sustainable chemistry.
2. Understand stoichiometric calculations and relate themto green process metrics.
3. Apply alternative solvent media and energy sources for chemical processes.
4. Discuss the renewable requirements for the chemical industry, present and under development.

**UNIT-1 Introduction to Green Chemistry**

Introduction to green chemistry need for green chemistry. Goals of green chemistry.Limitations/ obstacles in the pursuit of the goals of green chemistry.

**UNIT-2Principles of Green Chemistry**

Principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis; Prevention of Waste/ byproducts/ toxic products; maximum incorporation of the materials used in the process into the final products (Atom Economy).

**UNIT-3Designing a Chemical synthesis**

Designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions -; selection of starting materials; designing of biodegradable products;
Green Synthesis of the following compounds: adipic acid, catechol, methyl methacrylate, urethane, benzyl bromide, citral, ibuprofen, paracetamol, furfural.

**UNIT-4Green Synthesis Reactions and some real world cases:** Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2.Enzymatic Inter esterification for production of no Trans-Fats and Oils, Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting.

**UNIT-5Trends in Green Chemistry**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; Green chemistry in sustainable development, Use of microwaves in green chemistry.

**TEXTBOOKS/REFERENCE BOOKS:**


1. V.K. Ahluwalia& M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P.T. Anastas& J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press
3. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M.C. Cann& M.E. Connely: Real-World cases in Green Chemistry, American

Chemical Society, Washington (2000).
5. M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).
6. Green Chemistry Theory and Practice. P.T.Anatas and J.C. Warner
7. Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
8. Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
9. Green Chemistry: Introductory Text, M.Lancaster
10. Principles and practice of heterogeneous catalysis, Thomas J.M.,Thomas M.J., JohnWiley.

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 8 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 1 | 2 | - | - | - | - | 3 | 2 | - | 2 |
| CO4 | 2 | 2 | 1 | 3 | 3 | 3 | 2 | 1 | 1 | 3 |

## ORGANIC CHEMISTRY LABORATORY-IV (MCH-271)

## Course Objectives:

1. Students will get acquainted with the unifying principles of spectroscopy.
2. Students will learn atomic absorption spectroscopy, its basic principle, instrumentation and applications.

## Course Outcomes:

1. The students have the detailed knowledge of analytical ore analysis of different element, quantitative organic compound analysis and also have the spectroscopic determination method.
2. Learn error analysis, statistical data analysis, volumetric analysis,chromatography, flame photometry.
3. Capable of synthesizing Organic compounds.

### PRACTICAL DESCRIPTION

1. Estimation of Glucose, Amino group, Phenol, and Amino acids.
2. Small scale synthesis and purification of the following:

   Succinic anhydride from succinicacid

   Diethyl phthalate from phthalicanhydride

   Acetophenonetooxime

   AnthronefromAnthracene

   Fries rearrangement: Phenylacetate

   Mannichreaction

   Cannizzaroreaction

   Aldolcondensation

   Diazotizationcouplings

   Phenolphthalein from phthalicanhydride.
3. UV, IR spectra and melting points of simple compounds

| POs Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | - | - | 1 | - | 2 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | - | 1 | - | 3 | - | 1 | 2 |
| CO3 | 2 | 2 | 3 | 2 | - | - | 3 | 3 | 3 | 2 |

## Project/Dissertation

### Description

Dissertation will carry marks for continuous assessment, dissertation write-up, its presentation and viva-voce. This will be evaluated at the end of fourth semester.

Students will work on a research topic assigned to him/her by their supervisor/mentor with a purpose to develop a collective approach to study, analyze and solve the problem. Students are required to collect, analyze the data, and submit their dissertation at the end of the semester.

| S.No. | Course details |
|---|---|
| 1. | Research work |
| 2. | Seminar |
| 3. | Evaluation by Research committee |
| 4. | Thesis writing |
| 5. | Research work by taking 260 credit hours |

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