

CHEMISTRY-III (ORGANIC CHEMISTRY)

CREDIT HOURS: 3

COURSE OBJECTIVES

The objective of the course is for students

1. To learn the fundamentals of organic chemistry.
2. To develop an understanding and appreciation of both structure and chemical transformations of organic molecules.
3. Will acquire basic concepts of electronic structure and be able to apply them to solve problems from various areas of organic chemistry, including stereochemistry, reactivity patterns and synthesis.
4. Improvements in learning strategies, critical-thinking, and problem-solving skills are an expected outcome.

COURSE CONTENT:

1. Basic Concepts in Organic Chemistry

Hybridization of orbitals of carbon atoms in alkanes, alkenes, alkynes and arenes. Hybridization of orbitals of nitrogen, oxygen and sulfur atoms in various functional groups, Localized and delocalized chemical bonding; Conjugation and hyper conjugation; Resonance, rules of resonance, resonance energy, resonance hybrid, factor effecting the resonance; Inductive effect, applications of inductive effect and resonance on various properties of organic compounds; Steric effect and its applications, Hydrogen bonding and its effects on various properties of organic compounds, Tautomerism.

2. Nomenclature of Organic Compounds

Nomenclature of alkanes, alkenes, alkynes, cycloalkanes, bicycloalkanes, spiroalkanes, Monofunctional and polyfunctional derivatives of open chain and cyclic compounds; Polysubstituted benzenes; Polycyclic hydrocarbons such as naphthalene, anthracene, phenanthrene and their derivatives; Heterocyclic compounds.

3. Hydrocarbons

a) Alkanes and Cycloalkanes

Preparation of alkanes from alkyl halides, coupling of alkyl halide and alkylboranes, reduction of carbonyl compounds, Kolbe's electro synthesis, Corey-house-synthesis, hydrogenation of alkenes and alkynes.

Reactions of alkanes with halogens, their mechanism and comparison of reactivities of halogens; combustion, isomerization, nitration and sulfonation.

Preparations of cycloalkanes by Freund synthesis, Hydrogenation of cyclic alkenes,; Structure and stability of cycloalkanes; Reaction of cycloalkanes.

b) Alkenes and Alkynes Preparation of alkenes from elimination reaction of alkyl halides and alcohols; Mechanism and orientation of eliminations; Dehalogenation of vicinal dihalides with mechanism; Pyrolytic eliminations. Reactions of alkene;

relative stability and reactivity; Addition of halogens, additions of halogen acids and the rules governing these reactions, hydration reactions, oxidation reactions including epoxidation and hydroxylation, polymerization; Simon-Smith and Diels-Alder reactions. Preparation of alkynes by carbide process, dehydrohalogenation of dihalides and alkylation of terminal alkynes. Reactions of alkynes: addition reactions with mechanisms, hydration reactions, oxidation, reduction, hydroboration, formation of metal acetylides, polymerization (linear and closed chain).

c) **Aromatic Hydrocarbons**

Structure of benzene, Resonance energy of benzene, Aromaticity, criteria for aromaticity, Evidences of aromaticity; Natural sources of aromatic hydrocarbons; Preparation of aromatic hydrocarbons by different methods.

Reaction of aromatic hydrocarbons: electrophilic aromatic substitution reactions i.e. nitration, halogenation, Friedel-Crafts reaction and its limitations, sulfonation; Orientation and reactivity of substituted benzenes;

Nucleophilic aromatic substitution reactions; reaction such as addition, hydrogenation, Birch reduction, and oxidation reactions of side chains.

Polycyclic aromatic hydrocarbons like naphthalene, anthracene and phenanthrene, their resonance structures and relative stabilities; Synthesis of naphthalene; Electrophilic substitution reactions of naphthalene; Oxidation and reduction reactions; Brief description of orientation and reactivity of naphthalene

4. Isomerism

- **Conformational isomerism:** conformational analysis of ethane, n-butane, cyclohexane, mono- and di-substituted cyclohexanes.
- **Optical isomerism:** optical activity; chirality and optical activity; enantiomers, diastereomers; racemates and their resolution; D, L and R, S conventions; Optical Isomerism in cyclohexanes, biphenyls and allenes
- **Geometrical Isomerism:** cis and trans isomers; E-Z convention; Determination of configuration of the isomers; Inter-conversion of geometrical isomers; Geometrical isomerism in cyclic compounds.

5. Alkyl halides

Preparation of alkyl halides from alcohols and carboxylic acids;

Chemical reactions: Aliphatic nucleophilic substitution reactions, SN_1 and SN_2 mechanism, effects of the nature of substrate, attacking nucleophile, leaving group and the nature of solvent. Elimination reactions, E_1 and E_2 , mechanisms, orientation of elimination (Hoffmann and Saytzeff rules).

Grignard Reagents; synthesis, structure, and reactions with active hydrogen compounds, carbonyl compounds such as aldehydes, ketones, esters, acid halides and CO_2 ; Reactions with nitriles, ethylene oxide, sulphur and oxygen.

6. Chemistry of Hydroxyl Group containing Compounds and Ethers

Alcohols: Physical properties; Preparation of alcohols by the reduction of carbonyl compound; Reactions of alcohol with metals, organic and inorganic acids; Oxidation of alcohols; Distinction between primary, secondary and tertiary alcohols; Preparation of diols, triols and their important reactions and uses.

Phenols: Physical properties; Synthesis of phenols; Reactions of phenols such as acylation, Friedel-Crafts reaction, nitration, sulfonation, carbonation, formylation and diazo coupling.

Ethers: Physical properties; Preparation of ethers from alcohols, alkyl halides and alkenes; Reactions of ethers; Brief introduction of crown ethers and polyethers.

Evaluation Criteria

Examination	Type	Marks
Internal Examination	Sessional Work	15%
	Mid-Semester	25%
External Examination	Final Semester	60%

Recommended Books:

1. C.K. Ingold, "Structure and mechanism in organic chemistry", C.B.S.
2. I.L.Finar, "Organic Chemistry", Vol. I, Pearson Education, L.P.E.
3. I.L.Finar, "Organic Chemistry", Vol. II, 5th Edition, L.P.E.
4. Jerry March, "Advanced Organic Chemistry, Reaction, Mechanism and Structure", 5th Edition, Wiley Inter Science.
5. Morison and Boyd, "Organic Chemistry", 6th Edition, Prentice Hall.
6. Seyhan N. Ege, "Organic Chemistry Structure and Reactivity", 3rd Edition, The University of Michigan, A.I.T.B.S. Publishers & Distributors (Regd.).
7. Thomas H. Lowry, Kathleen Schueller Richardson "Mechanism and Theory in Organic Chemistry", 3rd Edition, Harper and Row Publishers, New York.
8. Alder, Baker, Brown, "Mechanism in Organic Chemistry", Wiley Publishers.
9. Atkins Carey, "Organic Chemistry", A Brief Course, 2nd Edition.
10. Peter Sykes, "A guide book to mechanism in organic chemistry", 6th Edition, Pearson Education, Singapore.
11. Carruthers, "Modern Methods of Organic Synthesis", Cambridge low Priced Edition, Cambridge.
12. Harris, Wamser, "Fundamentals of Organic Reaction Mechanism", Wiley Publishers.
13. G. Malcolm, Dyson, "A Manual of Organic Chemistry", Vol. I.
14. Canant Blat, "The Chemistry of Organic Compound", 5th Edition.
15. R. Panico, W.H.Powell, Jean-Claude Richer, "A guide to IUPAC Nomenclature of Organic Compounds", Blackwell Sci. Publication, 1993.

CHEMISTRY LAB-III (ORGANIC CHEMISTRY)

CREDIT HOURS: 1

1) Compound Analysis

Identification of organic compounds containing only one functional group with special emphasis on compounds containing following functional groups.

-COOH, -OH, C=O, -NH₂, and -CONH₂

2) Basic Experimental techniques used in organic chemistry

- 1) Filtration
- 2) Simple and fractional distillation
- 3) Solvent extraction
- 4) Sublimation
- 5) Re-crystallization
- 6) Column Chromatography

3) Estimations (volumetric)

- 1) Determination of molecular weight of a carboxylic acid.
- 2) Estimation of amide group and glucose.

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Recommended Books:

1. K.M.Ibne Raza, M.A. Rehman, Abdur Rehman, "Organic Chemistry", The Carvan Book House, Lahore.
2. B.S. Furniss, "Vogel's T.B of Practical Organic Chemistry", Addison Wesley Longman, Inc. 1989.
3. Frederick George Mann and Saunder, "Practical Organic Chemistry", The English Language Book Society, 1960.
4. Daniel R. Palleras, "Experimental Organic Chemistry , John Willey & Sons" Inc., 2000.
5. James A. Moore, "Experimental methods in Organic Chemistry", Holt-Saunders Int., 1983.
6. R.L. Shriner, R.C Fuson, D.V. Curtin and T.C Morrill "The systematic identification of organic compounds, 6th ed. John Willey & sons, 1979.