DEPARTMENT OF CHEMISTRY

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B.Sc. HONOURS UNDER CBCS SYSTEM

COURSE OUTCOMES (ORGANIC CHEMISTRY)

COURSE OUTCOME (ORGANIC CHEMISTRY)

SEMESTER – I

THEORY

Course Code: **CC-1**

Course Title: **Organic chemistry: Basics of Organic chemistry, Stereochemistry I**

- Students will be able to study the subject initially by understanding the basic things for chemical reactions *i.e.* substrate and reagents, types of reagents-electrophilic and nucleophilic, the hybridization and geometry of molecule, homolytic and heterolytic fission, electron mobility- inductive effect, resonance, hyperconjugation etc.
- Students will know the different types of concerted reactions in organic chemistry and orbital correlation approaches. They will understand Frontier molecular orbital approach [FMO] and Aromatic transition state approach according to Huckel. To know the ideas of different types of π-MOs of cyclic and acyclic system, Frost diagram etc. They will also have concept of aromatic, non-aromatic, antiaromatic, homoaromatic compounds.
- Here students will also learn the types of organic reactions and fundamentals of organic reaction mechanism, use of 'curly arrows' to depict reaction mechanisms. They will understand the role of various reaction intermediates like carbanion, carbocation, carbenes, radicals etc. in organic reactions.
- Students can understand the basic concepts of stereochemistry. They will have ideas of various projection formulas, Concept of asymmetry, dissymmetry, pseudo asymmetry,

stereogenicity, chirotopicity, enantiomeric, diastereomeric relationship, R and S; E and Z; D and L nomenclature, specific and molar rotation, racemisation, resolution, optical purity.

- Students can learn the separation and purification of an organic mixture by chemical/solvent separation methods. They can know how melting point and boiling point of an organic compound determined and how organic pure compounds are identified by a chemical test.

PRACTICAL

Course Code: **CC-1**

Course Title: **Organic chemistry-I (Prac): Basics of Organic chemistry**

- Based upon solubility, (using common laboratory reagents like water, dil. HCl, dil. NaOH, dil. $NaHCO_3$, etc.) students will be able to separate the components of a binary solid mixture (Benzoic acid/p-Toluidine; pNitrobenzoic acid/p-Aminobenzoic acid; p-Nitrotolune/p-Anisidine.); purification of any one of the separated components by crystallization and determination of its melting point.
- Students will be able to determine the boiling point of common organic liquid compounds e.g., ethanol, cyclohexane, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide.
- They can identify pure organic compound by chemical test(s) [Solid compounds: oxalic acid, succinic acid, resorcinol, urea, glucose and salicylic acid. Liquid Compounds: acetic acid, ethyl alcohol, acetone, aniline and nitrobenzene].

COURSE OUTCOME (ORGANIC CHEMISTRY)

SEMESTER – II

THEORY

Course Code: **CC-4**

Course Title: **Organic chemistry: Stereochemistry II, Reaction mechanism, Substitution and Elimination reactions**

- Students will gain an understanding of the reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry. Concept of topicity of ligands and faces, pro-R/pro-S, pro-E/pro-Z and Re/Si, P/M descriptors. Chirality arising out of stereo axis (allenes, spiro compounds, alkylidenecycloalkanes and biphenyls) atropisomerism.Recognize stereochemistry and be able to apply the Cahn-Ingold-Prelog system to designation of stereochemistry.
- Concept of organic acids and bases, comparison between nucleophlicity and basicity; HSAB principle; application of thermodynamic principles in acid-base equilibria, Tautomerism- various types.
- To get an idea about the various kinetic and thermodynamic factors which control the organic reactions. Concept of isotope effect: primary and secondary kinetic isotopic effect (kH/kD); principle of microscopic reversibility all are skill development activity for a graduate student.
- Understand SN1, SN2 and SNi, SN2', SN1' (allylic rearrangement) mechanism and stereochemistry, understand NGP by pi and sigma bonds, role of crown ethers and phase transfer catalysts. Know the mechanism and stereochemistry of E1, E2 reaction. Compare the differ between types of elimination and substitution reaction.
- To gain the skill to prepare organic compounds using greener protocols. Enable the students to prepare organic compounds via two step synthetic sequences.

PRACTICAL

Course Code: **CC-4**

Course Title: **Organic Chemistry-II (Prac)**

- Students can perform the following reactions:
    1. Nitration of acetanilide
    2. Condensation reactions: Synthesis of 7-hydroxy-4-methylcoumarin
    3. Hydrolysis of amides/imides/esters
    4. Acetylation of phenols/aromatic amines (using Zn-dust/Acetic Acid)
    5. Benzoylation of phenols/aromatic amines
    6. Side chain oxidation of toluene and p-nitrotoluene
    7. Diazo coupling reactions of aromatic amines
    8. Bromination of acetanilide using green approach (Bromate-Bromide method)
    9. Green 'multi-component-coupling' reaction: Synthesis of dihydropyrimidone
    10. Selective reduction of m-dinitrobenzene to m-nitroaniline

- Students will be able to (i) calculate percentage yield and theoretical yield. (ii) determine the melting point of the purified product.

COURSE OUTCOME (ORGANIC CHEMISTRY)

SEMESTER – III

THEORY

Course Code: **CC-7**

Course Title: **Organic chemistry: alkenes and alkynes Aromatic Substitution Carbonyl and Related Compounds**

- To impart the students a thorough knowledge about the mechanism, reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity of electrophilic addition to C=C bonds.
- To get a brief idea about various reactions of alkene and alkyne : hydrogenation, halogenations, iodolactonisation, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, epoxidation, syn and anti-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; Birch reduction and also to give an outlineapplications of these reactions in organic chemistry.
- Students become eligible to study the mechanism, reactivity and orientation of different aromatic electrophilic substitution reactions: nitration, sulfonation, halogenation, Friedel-Crafts reaction, chloromethylation, Gatterman-Koch, Gatterman, Houben-Hoesch, Vilsmeier-Haack, Reimer-Tiemann, Kolbe-Schmidt, Ipso substitituion.
- To understand the basic concepts and mechanism of nucleophilic aromatic substitution reactions: unimolecular, addition-elimination and benzyne intermediate mechanism.
- To understand: how to name different aldehydes and ketones, the reactivity of different carbonyl compounds towards nucleophilic reactions, how to write the products for reactionsof carbonyl compounds with different types of compounds (NaBH4, LiALH4, Grignard Reagents, HCN, Water under acid and base conditions, Alcohols, Amines), to recognize mechanism of of different reactions related to carbonyl compounds.

PRACTICAL

Course Code: **CC-7**

Course Title: Organic Chemistry-III (Prac)

- Students will be able to perform Qualitative Analysis of Single Solid Organic Compounds by maintaining the following steps:
    1. Detection of special elements (N, S, Cl, Br) by Lassaigne's test
    2. Solubility and classification (solvents: H_2O, 5% HCl, 5% NaOH and 5% $NaHCO_3$)
    3. Detection of the functional groups by systematic chemical tests [aromatic amino (-NH_2), aromatic nitro (-NO_2), amido (-$CONH_2$, including imide), phenolic – OH, carboxylic acid (-COOH), carbonyl (-CHO and >C=O)]
    4. Melting point of the given compound 6. Preparation of one derivative of the given sample.

COURSE OUTCOME (ORGANIC CHEMISTRY)

SEMESTER – IV

THEORY

Course Code: **CC-10**

Course Title: **Organic chemistry: Nitrogen compounds, Rearrangements, The Logic of Organic Synthesis, Organic Spectroscopy**

- The students will understand some fundamental aspects of Nitrogen compounds. They will learn preparation, separation and identification of primary, secondary and tertiary amines and reactions such as Eschweiler–Clarke methylation, diazo coupling reaction, Mannich reaction. They also learn preparation and reactions of Nitro compounds, diazomethane and diazoacetic ester.
- Students are able to write mechanism and stereochemical features of different rearrangement reactions.

  a) Students will gain an understanding of Rearrangement to electron-deficient carbon such as Wagner-Meerwein, pinacol-pinacolone, benzil-benzilic acid, dienone-phenol, Wolff rearrangement in Arndt-Eistert synthesis, Demjanov rearrangement.

  b) Students will gain an understanding of Rearrangement to electron-deficient nitrogen: Hofmann, Curtius, Lossen, Schmidt and Beckmann.

  c) Students will gain an understanding of Rearrangement to electron-deficient oxygen: Baeyer-Villiger oxidation, cumene hydroperoxide-phenol rearrangement and Dakin reaction.

  d) To gain the skill to prepare organic compounds using Rearrangement reactions by green approach: Fries rearrangement, Claisen rearrangement, Beckmann rearrangement, Baeyer-Villiger oxidation.
- To know the various methods employed for reactions like oxidation, reduction, carbocyclic and heterocyclic ring formation etc. To get insights into novel reactions and reagents in organic synthesis. To know the utility of protecting group strategy in organic synthesis. To be familiarize the students with the basic principles of retro syntheses, biosynthesis.This

includes fragmentation and retrosynthetic analysis and also finding synthon of a target molecule.

- To know the basics principle of different techniques employed in molecular spectroscopy. To study the origin, instrumentation and important applications of UV, IR, NMR techniques.

  a) Students should have the ability to explain terms in UV spectroscopy such as electronic transitions, chromophores and auxochromes; Bathochromic and Hypsochromic shifts, λ_{max} calcucation.

  b) The students will understand some fundamental aspects of IR spectroscopy such as molecular vibrations, application of Hooke's law, force constant, fingerprint region, factors affecting stretching frequencies.

  c) Students should have the ability to explain common terms in NMR spectroscopy such as chemical shift,coupling constant and anisotropy and describe how they are affected by molecular structure.

  d) To get a deep insight into the various spectroscopic methods used for the characterization of organic compounds. Enable the students to elucidate the structure of compounds by analyzing the spectral data.

PRACTICAL

Course Code: CC-10

Course Title: Organic Chemistry-IV (Prac)

- Students will be able to carry out the following reactions:
  1. Estimation of glucose by titration using Fehling's solution
  2. Estimation of vitamin-C (reduced)
  3. Estimation of aromatic amine (aniline) by bromination (Bromate-Bromide) method
  4. Estimation of phenol by bromination (Bromate-Bromide) method
  5. Estimation of formaldehyde (Formalin)
  6. Estimation of acetic acid in commercial vinegar
  7. Estimation of urea (hypobromite method)
  8. Estimation of saponification value of oil/fat/ester.

Course Code: SEC-2

Course Title: Pharmaceuticals Chemistry

Student will be able to:

- Know the basics of medicinal chemistry.
- Recognize the drug structure and predict its pharmacologic action.
- Describe the mechanism of action, use and mode of application of the selected drugs on the basis of their structure,
- Describe and perform synthesis of the drugs and determine the reaction yield.
- Know briefly about the structure, chemistry, mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, CNS acting drugs, Antipyretic Agents, Cholinergic Drugs, Diuretics, Cardivascular, Analgesic Agents, Antilaprosy agents, HIV-AIDS related drugs.

COURSE OUTCOME (ORGANIC CHEMISTRY)

SEMESTER – IV

THEORY

Course Code: **CC-12**

Course Title: **Organic chemistry: Carbocycles and Heterocycles, Pericyclic reactions, Carbohydrates, Biomolecules, Alkaloids and Terpenoids**

- This course aims at providing theoretical understanding of carbocyclic compounds (Polynuclear hydrocarbons) which includes various methods for ring synthesis and application of those methods for the preparation of naphthalene, anthracene, phenanthrene and theirderivatives.
- The technique of synthesis of heterocyclic compounds is important in the synthesis of different drugs. This course gives the quantitative ideas about the synthesis, properties, orientation and uses of such heterocyclic compounds like pyrrole, pyridine quinolene, thiophene, furan,indole, quinoline and isoquinoline.
- Students should be able to identify the various open and closed forms of carbohydrates(D-glucose & D-fructose). Students will have the ability to explain the terms mutarotation; epimerization. They will have a brief idea about Haworth representations and non-planar conformations of sugar. The students will get familiar with particular reactions for the stepping–up and stepping–down of aldoses and ring-size determination of different types of carbohydrates.
- This course gives the students the theoretical basis of pericyclic reactions and also helps them to find a way to carry out different pericyclic reactions, i.e., cycloaddition, electrocyclic and Sigmatropic reactions. They can explain the Frontier Molecular Orbital (HOMO-LUMO) approach, Woodward-Hofmann selection rules for all the pericyclic reactions and can solve problems based on FMO approach.
- Students will be able to recognize all common amino acids and understand the different levels of protein structure. Students will be able to know the mechanisms for synthesis amino acids by different methods like Strecker, Gabriel Phthalimide, Malonic ester,

Erlenmeyer azlactone, Bücherer hydantoin synthesis. Students should have the ability to explain the terms isoelectric point, zwitterions, peptides. They can know about peptide synthesis, C-terminal and N-terminal unit determination of amino acid, nucleosides and nucleotides, elementary idea of double helical structure of DNA (Watson - Crick Model), complimentary base–pairing in DNA.

- Alkaloids and terpenes are two very important classes of organic chemicals available in different kind of drugs and perfumery chemicals like ephedrine, conium, citral etc. Student will be able to know the synthesis and structural determination of these classes of chemicals and their reactions also.

PRACTICAL

Course Code: CC-12

Course Title: Organic Chemistry-V (Prac)

- Students will be able to carry out Chromatographic Separations using following techniques
  1. TLC separation of a mixture containing 2/3 amino acids
  2. TLC separation of a mixture of dyes (fluorescein and methylene blue)
  3. Column chromatographic separation of mixture of dyes
  4. Paper chromatographic separation of a mixture containing 2/3 amino acids.
- Students will be able to perform Spectroscopic Analysis of Organic Compounds in the following way:
  1. Assignment of labelled peaks in the 1H NMR spectra of the known organic compounds explaining the relative δ-values and splitting pattern
  2. Assignment of labeled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included).
- The students can record full spectral analysis of the following compounds:
  a. 4-Bromoacetanilide
  b. 2-Bromo-4-methylacetophenone
  c. Vanillin
  d. 2-Methoxyacetophenone
  e. 4-Aminobenzoic acid
  f. Salicylamide
  g. 2–Hydroxyacetophenone
  h. 1,3-Dinitrobenzene

i. Benzylacetate

j. trans-4-Nitrocinnamaldehyde

k. Diethyl fumarate

l. 4-Nitrobenzaldehyde

m. 4-Methylacetanilide

n. Mesityl oxide

o. 2-Hydroxybenzaldehyde

p. 4-Nitroaniline.

COURSE OUTCOME (ORGANIC CHEMISTRY)

SEMESTER – VI

THEORY

Course Code: DSE-3

Course Title: Green Chemistry

- This course gives the students the theoretical basis of twelve principles and goals of green Chemistry. They will be able to know atom economy and can calculate atom economy of the rearrangement, addition, substitution and elimination reactions.
- Students will be able to know briefly green solvents– supercritical carbon dioxide, water as green solvent, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents.
- The students will understand some fundamental aspects of use of microwaves and ultrasonic energy in green processes. They will know preferential use of catalytic reagents over stoichiometric reagents; comparison of heterogeneous and homogeneous catalysis, bio-catalysis, photo-catalysis.
- Students can know about green synthesis of adipic acid, Microwave assisted reactions in water: Hofmann Elimination, oxidation of toluene and alcohols; Diels-Alder reaction and Decarboxylation reaction; Ultrasound assisted reactions: Simmons-Smith reaction.
- Students can know the application of surfactant absorbed carbon dioxide for dry cleaning and precision cleaning of garments; synthetic azopigments to replace toxic organic and inorganic pigments.
- They will have the idea of oxidising and reducing reagents and catalysts; multifunctional reagents; combinatorial green chemistry.

After completion of the course, the learner shall be able to understand:

Learning objective:

1. Green chemistry and its principles
2. Green synthesis and reactions
3. Green chemistry for sustainable solutions

4. Understanding principles of green chemistry

5. Understanding design of chemical reactions/chemical synthesis using green chemistry principles

6. Atom economy and design of chemical reactions using the principle

7. Understanding the use of green chemistry principle and processes in laboratory reactions.

Self-study:

1. Use of green chemistry in designing new laboratory experiments
2. Use of principle of atom economy and design experiments using the principle
3. Use of green chemistry in combinatorial chemistry and biomimetic catalyst.

PRACTICAL

Course Code: DSE-3

Course Title: Green Chemistry (Prac)

- Students will be able to perform the following experiments:
    1. Preparation of propene
    2. For the calculation of atom economy different types of reactions, like addition, elimination, substitution and rearrangement
    3. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide
    4. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

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