

Chemistry-II: Chemical Transformations and States of Matter

1. **Faculty:** Faculty of Chemical Sciences
2. **Course Code:** CHE102
3. **Course Title:** Chemical Transformations and States of Matter
4. **Number of Credits:** 3+0+1
5. **Course objectives:**
 - The core course Organic Chemistry is designed in a manner that it forms a cardinal part of the learning of organic chemistry for the subsequent semesters. The course is infused with the recapitulation of the fundamentals of organic chemistry and the introduction of a new concept of visualizing organic molecules in a three-dimensional space. To establish the applications of these concepts, the functional groups- alkanes, alkenes, alkynes, and aromatic hydrocarbons are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.
 - To develop basic and advanced concepts regarding the three states of matter.
 - To derive the expressions for determining the physical properties of gases, liquids, and solids.
6. **Minimum prerequisites for taking this course, if any:**
7. **Course structure with units, if applicable:**

Unit 1: Aromaticity: benzenoids and Hückel's rule.

Stereochemistry: Conformations with respect to ethane, butane, and cyclohexane, interconversion of Wedge Formula, Newmann, Sawhorse, and Fischer representations, the concept of chirality (up to two carbon atoms). configuration: geometrical and optical isomerism; enantiomerism, diastereomerism, and meso compounds). Threo and erythro; D and L; *cis-trans* nomenclature; CIP Rules: R/ S (for up to 2 chiral carbon atoms) and E / Z nomenclature (for up to two C=C systems).

(Lectures: 10)

Unit 2: Aliphatic Hydrocarbons

Functional group approach for the following reactions: preparations, physical property & chemical reactions to be studied with the mechanism in context to their structure.

Alkanes:

Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical substitution: Halogenation.

Alkenes:

Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides

(Saytzeff's rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). Reactions: *cis*-addition (alk. KMnO_4) and *trans*-addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, Oxymercuration-Demercuration, Hydroboration oxidation.

Alkynes:

Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline KMnO_4 , ozonolysis, and oxidation with hot alk. KMnO_4 . Hydration to form carbonyl compounds.

(Lectures: 10)

Unit 3: Gaseous state-I Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, diffusion of gases. **Gaseous state-II:** Behaviour of real gases van-der waal equation of state; virial equation of state, critical phenomena; p-V isotherm of CO₂, van-der waal equation and critical state, Law of corresponding states and liquefaction of gases.

(Lectures: 13)

Unit 4: Liquid State: Qualitative treatment of the structure of Liquid State, Physical properties of Liquids, vapor pressure, surface tension, and viscosity and their determination. Effect of addition of various solutes on surface tension and viscosity. Surfactants and their role in cleansing.

(Lectures: 5)

Unit 5: Crystal structure: Hauy's idea and space lattices, crystal systems, Fourteen Bravais Lattices, Diffraction of X-rays by crystals-Bragg's law, Powder method, Diffraction pattern of a Cubic system, crystal structure of NaCl & KCl, Density of cubic crystals.

(Lectures: 7)

Lab Tech:

Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of purity: Determination of M.P./B.P.
3. Separation of mixtures by chromatography: Measure the R_f value in each case (combination of two compounds to be given).
 - a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine, or any other amino acid) by radial/ascending paper chromatography.
 - b) Identify and separate the sugars present in the given mixture by radial/ascending paper chromatography.

Physical Chemistry

1. Surface tension measurements using a Stalagmometer.
 - i. Determine the surface tension of aqueous solutions by (i) drop number (ii) drop weight method.
 - ii. Study the variation of surface tension with different concentrations of detergent solutions. Determine CMC.
2. Viscosity measurement using Ostwald's viscometer.
 - i. Determination of the co-efficient of viscosity of an unknown aqueous solution.
 - ii. Study the variation of co-efficient of viscosity with different concentrations of Poly Vinyl Alcohol (PVA) and determine the molar mass of PVA.
 - iii. Study the variation of viscosity with different concentrations of sugar solutions.

8. Reading suggestions:

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Eliel, E. L.; Wilen, S. H. (1994), Stereochemistry of Organic Compounds; Wiley: London.
4. Singh, S.P.; Prakash, O., (2017), Reaction Mechanism in organic chemistry, Laxmi Publications.
5. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.
6. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
7. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
8. Khosla, B. D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
9. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

9. Evaluation:

Theory:	Mid-semester Written Examination	: 40% Marks
	End-semester Written Examination	: 40% Marks
	Quiz / Assignment/Presentation (oral / poster)/other	: 20% Marks