Department of Chemistry
Government Degree College, Baramulla (Autonomous)

Semester 5th **Major/Minor Course**

Subject: Chemistry

Course Title: Chemistry-VI **Course Code:**
Credit: Theory: 04; Practical: 02 **Contact Hours: (64 Th + 64 Pr)**

Course Objectives

1. To introduce the basic concepts of electrochemistry.
2. To introduce the basic concepts of addition reactions in organic synthesis.
3. To introduce the basic concepts of nuclear chemistry.

Course Outcomes

Upon completion of the course students will be able to

1*. Understand the concept of conductance in electrolytic solutions, electrolysis and redox reactions involved in electrode reactions.*
2. Learn the different types of addition and free radical substitution reactions.
3. Understand the applicability of nuclear chemistry.

UNIT I: Electrochemistry I (16 Contact hours)

Equivalent and molar conductivity, migration of ions and Kohlrausch's law, Transport number, definition and determination by Hittorf's method and moving boundary method. Application of conductivity measurements: determination of degree of dissociation, dissociation constants of acids and solubility product of a sparingly soluble salts.

Types of reversible electrodes: gas-metal-ion, metal-metal ion, metal-insoluble salt- anion and redox electrodes. Electrode potential, standard electrode potential, standard hydrogen electrode, reference electrodes, sign conventions. Electrode reactions, Nernst equation, determination of cell E.M.F, electrochemical series and its significance. Electrolytic and Galvanic cells reversible and irreversible cells, conventional representation of an electrochemical cell. Measurement of EMF of a cell. Calculation of thermodynamic functions of cell reactions (ΔG, ΔH and ΔK).

Unit-II Electrochemistry-II (16 Contact hours)

Ion-solvent interactions: Born model of ion-solvent interactions, Structural models of ion - solvent interactions: Gouy-Chapman Model, Helmoltz Model and Gouy-Chapman-Stern model.Experimental determination of salt-solvent interactions.

Ion - ion interactions: Debye - Huckel theory of ion - ion interactions. Verification of Debye-Huckel limiting law. Activity coefficients at moderate concentrations and higher concentrations. Activity coefficients as a function of ion-ion and ion-solvent interactions. Mean activity coefficients.

Debye-Huckel-Onsager conductance equation and brief idea of its extension.

Unit-II Mechanistic Study of Organic Reactions (16 Contact hours)

Addition to carbon-carbon and carbon-hetero multiple bonds: Overview of addition of electrophiles and nucleophiles to multiple bonds. Ene-reaction, Michael reaction and Sharpless assymetric epoxidation. Chemoselective, diastereoselective and enantioselective addition of hydride donors and organometallic compounds to acyclic/cyclic carbonyl

compounds. Mechanism of Mannich, Knoevenagel, Robinson annulation, Claisen, Dickman and Stobbe's reactions. Mechanism of conjugate nucleophilic addition to α, β- unsaturated carbonyl compounds.

Free Radical Substitution: Free radical substitution mechanisms, reactivity and neighbouring group assistance in aliphatic and aromatic substrates. Effect of solvent on reactivity. Free radical reagents, Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes, free radical rearrangements, Hunsdiecker reaction.

UNIT IV: Nuclear Chemistry (16 Contact hours)

The nucleus: Subatomic particles, nuclear forces (Meson theory), nuclear size and density. Stability of nucleus: n/p ratio, binding energy, packing fraction, structure of nucleus- Shell model and Liquid drop model. Radioactivity: Natural and induced. Radioactive decay-α-decay, β-decay, γ-decay; neutron, emission, positron emission and electron capture. Group displacement law and radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters, scintillation counters. Applications: Carbon dating, neutron activation and isotope dilution analyses Radiation chemistry: Units of radiation; LET and G-Value. Dosimetry, radiation chemistry of oxygen.

Books recommended

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford university Press (2010)

2. G W Castellan, Physical Chemistry, 4th Ed., Narosa (2004)

3. B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, Vishal Publishing Co.48 edition (2021)

4. Textbook of Organic Chemistry, V.K Ahluwalia. Ane books 2010.

5. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers. 3rd Edition (2021)

6. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and company Ltd. (2020)

7. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons. (2007)

8. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi, (1942)

9. Organic Chemistry J. Claydon, N Greeves and S. Warren. Oxford University press 2nd Edn. 2012.

10. Advanced Organic Chemistry; 5th edn. ; F. A. Carey and R. J. Sundberg; Springer Plenum; 2007.

11. Structure and Mechanism in Organic Chemistry; 2nd edn. ; C. K. Ingold; CBS; 1994.

12. Essentials of nuclear chemistry H.J. Arnikar New Age International, 1995

13. Modern Electrochemistry vol. I and II John O'M Bockris, Maria Gamboa-Aldeco, Amulya K. N. Reddy; eBook ISBN · 0-306-47605-3; Print ISBN · 0-306-46166-8.

14. Nuclear and Radiation chemistry Sharma B. K, Goel publishing house Meerut.

PART II: LAB COURSE (64 hours)

Part-II: Physical Chemistry (Any three)

1. Determination of equivalent conductance, degree of dissociation and the dissociation constant of a weak acid.
2. Determination of equivalent conductance of a weak electrolyte at infinite dilution using Kohlraush's law.
3. To determine dissociation constants of an amino acid and hence the isoelectric point of the acid.
4. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.

Part-II: Organic Chemistry

1. Synthesis of Organic Compounds (Any three)
   a) Aspirin via Acetylation of Salicylic acid
   b) Iodoform from acetone
   c) α, β-unsaturated aldehyde/ ketone using aldol condensation.
   d) 2, 4-dinitrophenylhydrozone formation of aldehydes/ketones
2. Separation and Identification of binary and ternary mixtures of Organic Compounds.

Books recommended

1. Quantitative Chemical Analysis, D. C. Harris, 8thEdn. W. H. Freeman. And Co, 2010.
2. J. B. Yadav, Advanced Practical Physical Chemistry ; ; Edition, 16 ; Goel Pub., 2006.
3. Advanced Practical Organic Chemistry; N. K. Vishnoi; 3rdEdn; Vikas Publishing, 2009.
4. Comprehensive Practical Organic Chemistry: Qualitative analysis Ahluwalia, V.K. & Sunita Dhingra; Universities Press, India, 2004.
5. Vogel's Textbook of PracticalOrganic Practical Chemistry 8th Edn. B. S Furniss, A.J Hannaford, Peter W.G Smith,A. R Tatchel 2011.

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Semester 5th **Major Course**

Subject: Chemistry

Course Title: Chemistry-VII **Course Code:**
Credit: Theory: 04; Practical: 02 **Contact Hours: (64 Th + 64 Pr)**

Course Objectives

1. To sensitize the students about the importance of environment and ways to keep it pollution free.
2. To acquaint the students with essentials of Chemical Equilibrium.
3. To introduce the concepts of spectroscopic and Chromatographic techniques.

Course Outcomes

Upon completion of the course students will be able to understand

1. *The harmful impacts of chemicals on the environment.*
2. *The concept of chemical equilibria and colligative properties.*
3. *The principles of different analytical techniques viz spectroscopy and chromatography.*

UNIT I: Environmental Pollution (16 contact hours)

Physical characteristics of atmosphere, Stratification of atmosphere, Energy and mass transfer in the atmosphere, Chemical and photochemical reactions in the atmosphere, Acid-base reactions in the atmosphere, Organic and inorganic particulate matter in the atmosphere, Atmospheric pollutant gases, Acid rain, formation of acid rain and its effects.

Photochemical smog: Formation and effects, Greenhouse gases and global warming, Ozone layer depletion.

Water quality: Sources of water pollutants, pollution kinetics and reaction mechanism, water quality parameters; pH, turbidity, DO, BOD, COD, Eutrophication, putrification

Unit II .Chemical Equilibria and Colligative properties (16 Contact hours)

Equilibrium constant and free energy change. Reaction isotherm and reaction isochore, Clapeyron equation and Clausius-Clapeyron equation, applications. Thermodynamics of elevation in boiling point and depression in freezing point. Activity and activity coefficient. Thermodynamic mixing functions of ideal and non-ideal solutions.

Partially miscible liquids: Lower and upper Consolute temperatures, (examples of phenol-water, trimethylamine-water, nicotine-water systems).

Unit III Chromatographic techniques-I (16 Contact hours)

Introduction to chromatography: Basic Concept of chromatography; mobile phase and stationary phase. Classification of chromatographic methods, chromatogram, partition coefficient, retention time, retention volume, the capacity factor, Rf value, the selectivity factor theoretical plates and efficiency, Van Deemter equation.

Principles and applications of paper chromatography, Thin layer chromatography, Counter current chromatography for isolation of natural products.

Unit IV Chromatographic techniques-II (16 Contact hours)

Gas chromatography: Principle of Gas Chromatography. Instrumentation· carrier gas, sample injection systems, column configuration and column ovens.

Detectors: flame ionization detectors, thermal conduction detectors, electron capture detectors etc.

Columns: packed columns, solid support material, particle size; open tubular columns. The stationary phase materials.

Liquid chromatography: HPLC, column efficiency in liquid chromatography. Instruments for liquid chromatography; mobile gas reservoirs, solvent treatment system, pumping systems, liquid chromatographic columns, detectors.

Books Recommended:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch.
2 Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. Principles of Physical Chemistry by Puri Sharma Pathania.
4. Chromatographic Methods by A. Braithwaite, F J Smith Springer.2012.
5. Analytical Chemistry by Christian D. Gary.
6. Environmental Chemistry, S. E. Manahan, CRC Press LLC, 2000.
7. Environmental Chemistry; A. K. De, 7th Edn; New Age International Pvt Ltd; 2010.
8. Principles and Practice of Chromatography by Raymond P W Scott Taylor Francis 2020.

PART II: LAB COURSE (64 hours)

Environmental Chemistry

1. Determination of pH, acidity and alkalinity of a water sample.
2. Determination of total soluble salts in soil using conductance measurements.
3. Estimation of total hardness of water by EDTA method.
4. Determination of dissolved oxygen (DO) of a water sample.
5. To determine chloride ion in a given water supply by argentometric method.

Chromatographic separation:

1.Determination ion exchange capacity of anion exchange resin
2.Determination ion exchange capacity of cation exchange resin
3.Separation of binary mixture using Column chromatography.
4.Quantification of paracetamol/ ceftrioxone/ cefotaxim using HPLC

Books recommended

1. Experiments in Environmental Chemistry, S. Chauhan, S. P. Mohanty, 2010,
2. Experiments in Environmental Chemistry: A laboratory Manual, D. W. Connell and P.D. Vowles, Ist Edn., Pergamon International Library, 1980.

3. Laboratory experiments in Environmental Chemistry, De. Neal Boehnke, R. Del Delumyea, Prentice Hall, 2000.
5. Chromatographic Methods, A. Braithwaite, J. W. Smith, Springer Science, 2012.
6. Compendious Practical Organic Chemistry; Preparations, Isolation and Chromatography, S. M. Basavarajaiah, G. Y. Nagesh, K. Ramkrishna Reddy, Notion Press Media, 2021.
7. Chromatography: Advanced Separation Techniques, H. N. Bhatti, M. A. Hanif, 2021.

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Semester 5th **Major Course**

Subject: Chemistry

Course Title: Organic Chemistry **Course Code:**
Credit: Theory: 04 **Contact Hours: (64 Th)**

Course Title: Organic Chemistry-I

Course Objectives

4. To introduce the basic concepts of stereochemistry and asymmetric synthesis.
5. To introduce the basic concepts of pericyclic, oxidation and reduction reaction in organic synthesis.

Course Outcomes

Upon completion of the course students will be able to:

1. Understand the concept of stereochemistry and asymmetric synthesis in organic reactions.

2. Learn different types of pericyclic reactions.

3. Understand the role of oxidation and reduction in various organic reactions.

Unit-I Stereochemistry-II: (16 Contact hours)

Conformations: Origin of conformational energy. Angle and Pitzer strain. Conformational analysis of cycloalkanes, Mono and Di-substituted Cyclohexanes (1-2. 1-3, and 1-4), Effect of conformation on reactivity in acyclic and cyclic systems. Conformation of sugars & anomeric effect. Conformation of cyclohexene and cyclohexanones, bicycloheptane and norbornane.

Asymmetric Synthesis: Introduction to stereospecific and stereoselective reactions, determination of enantiomeric excess by optical activity, Homotopic, Diastereotopic and Enantiotopic atoms, groups and faces.

Principles of asymmetric synthesis: Use of chiral substrates, Nucleophilic addition on acyclic chiral carbonyl compounds, Cram's rule, Diastero-selectivity in Aldol reactions. Use of chiral auxillaries-alkylation of chiral enolates, Use of chiral reagents/Catalysts: hydroboration, hydrogenation, epoxidation, dihydoxylation.

Unit-II Pericyclic reactions (16 contact hours)

Definition and classification of pericyclic reactions. Woodward Hoffman rules. Frontier molecular orbital (FMO) concept (HOMO, LUMO and SOMO). FMO of π- electron systems: Ethene, 1,3-butadiene,1,3,5-hexatriene and allyl systems.

Cycloadditions: Thermal and Photochemical 2+2 and 4+2 cycloadditions. Suprafacial and antarafacial cycloaddition.

Electrocylic Reactions: Thermal and Photo-induced Electrocyclic reactions of 4n and 4n + 2 systems and their stereochemistry. Conrotatory and disrotatory motions.

Sigmatropic rearrangements: Classification; [1,3], [1,5], [1,7] and [3,3] sigmatropic shifts. Cope and Claisen rearrangements. Biological pericyclic reactions.

Unit-III Oxidation Reactions: (16 Contact hours)

Oxidation: Introduction, Oxidation of Alcohols using chromic acid, chromium oxide in dil H_2SO_4 (Jones reagent), PCC, PDC, potassium permanganate, DCC, DCC and DMSO, DDQ, Dess-Martin periodinane (DMP), Aluminium isopropoxide (Oppenauer oxidation), dimethylsulfoxide (DMSO)/oxalyl chloride (Swern oxidation), sodium hypochlorite, MnO_2 and periodic acid. Corey Kim oxidation.

Carbon-carbon multiple bonds: Epoxidation of alkenes using peracids and H_2O_2, formation of syn-1,2-Diols using OsO_4 or aqueous $KMnO_4$, Prevost hydroxylation and its modification by Woodward. Oxidation of alkenes using SeO_2.

Oxidative Cleavage of Carbon-Carbon Multiple Bonds: Cleavage using O_3 and $KMnO_4$.

Aldehydes: Oxidation using Tollen's reagent, $KMnO_4$, Chromic acid, Jones reagent, atmospheric oxygen, Baeyer-Villiger oxidation.

Unit-IV Reduction Reactions (16 Contact hours)

Reduction Reactions: Types of Reduction Reactions, Homogeneous and heterogeneous reduction of alkenes. Reduction of Alkynes and Arenes. Birch reduction.

Reduction of carbonyl compounds: Clemmensen and Wolf-Kishner reductions. Reductions using $LiAlH_4$ and $NaBH_4$, Bouveault-Blanc reduction, Meerwein Ponndorf Verley (MPV) reduction, McMurry reaction and Luche reduction.

Reduction of carboxylic acid and its derivatives: Reduction of carboxylic acid and its derivatives using $LiAlH_4$. Reduction of esters using DIBAL.

Reduction of alkyl halides using Tributyl Tin Hydride.

Some examples of stereoselective reductions.

Books recommended:

1. Reaction Mechanism in Organic Chemistry 3rd Ed., S.M. Mukherjee and S.P. Singh. (Macmillan- 1998).
2. Stereochemistry of Organic Compounds 2nd Ed., D. Nasipuri. (New Age Inter.- 2008)
3. Stereochemistry of Carbon Compounds - E.L.Eliel. (TMH -2007)
4. Stereochemistry of Organic Compounds 7th Ed. - P.S. Kalsi. (New Age Inter.- 2012).
5. Organic Reaction Mechanism, 4th Ed., V. K. Ahluwalia, Rakesh Kumar Parashar, Narosa Publications

6. Reduction in Organic Synthesis, V. K. Ahuliwalia, CRC Press
7. Advanced Organic Chemistry, Reactions, Mechanisms, and Structure, 6th Ed., Micheal B. Smith and Jerry March, Wiley
8. Advanced Organic Chemistry: Part B: Reaction and Synthesis, 5th Ed. Francis A. Carey, and Richard J. Sundberg, Springer
9. Name Reactions and Reagents in Organic Synthesis; 2nd Ed., Breadford P. Mundy, Michael G. Ellerd, Frank G. Favaloro Jr., Wiley
10. Organic Chemistry; 8th Ed. P. Y. Bruice, Pearson
11. Pericyclic Reactions; 2nd Ed. Ian Fleming, Oxford University Press, UK, 2015
12. Organic Reaction Mechanisms, 4th Ed. V. K. Ahuluwalia & R. K. Parashar, Narosa