SEMESTER IV

11.1.10. Course Code: DSC 10: ANALYTICAL CHEMISTRY4 (AC4)
Course Title: SEPARATION METHODS-II
Total Credits: 04 (Credits: Theory-02, Practical-02)
(Total Lectures: Theory- 30, Practical-60)

Objectives: Objective of this course is to learn the separation techniques and its application.

Learning Outcomes:
By the end of this course, students will be able to learn:

- Various types of separation techniques and their applications
- Electrophoretic techniques

Unit 1: Column Chromatography

A. General: columns, matrix materials, stationary phase, column packing, application of sample, column development and sample elution, detectors and fraction collectors, applications.

B. High performance liquid chromatography: Principle, column, matrices and stationary phases, column packing, mobile phase and pumps, application of sample, detectors, applications. **C. Adsorption chromatography:** Principle, adsorbents, solvents, nature of solute, operating parameters, retention volumes and times, applications.

D. Liquid-liquid partition, chromatography: Principle, normal phase chromatography, reversed phase liquid chromatography, applications.

E. Ion-exchange chromatography: Principle, ion exchangers, ion- exchange equilibria, ion-exchange resin selectivity, column operations (column development, detection of solute bands), factors affecting retention volumes, applications.

F. Gel chromatography: Principle, types of gels, separation by gel chromatography, applications.

(Lectures: 20)

Unit 2: Electrophoretic Techniques:

A. Principle, apparatus, support media (paper, cellulose acetate membranes, gels)

B. SDS-PAGE, native gels, gradient gels, isoelectric focusing, 2D-PAGE, continuous flow electrophoresis, detection, estimation and recovery of proteins in gels.

C. Western Blotting, Electrophoresis of Nucleic Acids, Capillary Electrophoresis.

D. Isoelectric Focusing.

(Lectures: 10)

PRACTICALS (Credits: 02, Laboratory Periods: 60)

1. Determination of the residual chlorine in city water supply using colorimetry (*Take at least two samples*).
2. Determination of adsorption isotherm of acetic acid on activated charcoal and determination of the adsorption constant (k).
3. Determination of the capacity of at least two anion exchange resins *e.g.* Amberlite type II (Dimethyl-2-hydroxyethylbenzyl ammonium-based and Amberlite type I trialkyl ammonium-based, DOWEX type II, etc.
4. Determination of the capacity of at least two cation exchange resins *e.g.* DOWEX-50 (sulphonic acid based), sodium polystyrene sulfonate, Amberlite-sulphonic acid based, *etc*).
5. To remove the hardness of the water by using ion exchange resins.
6. To separate Ni (II) and Zn (II) by ion exchange resins and quantify it by complexometric titration.
7. Determination of the solubility of $CaSO_4$ by ion exchange and complexometric titrations.

8. Separation of compounds using adsorption column chromatography.
(a) Separation of the mixture of *o*-nitro phenol and *p*-nitro phenol.
(b) Separation of the mixture of dyes (methylene blue and methyl orange).
(c) Separation of the mixture of *o*-nitro aniline and *p*-nitro aniline.
9. Determination of the void volume of a gel column.
10. Visit to Water Purification Plants.

REFERENCES:

- Mikes, O. (2000), Laboratory Handbook of Chromatographic methods, D. Van Nostrand Company Inc.
- Fifield,F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
- Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K.; (2000), Vogel's Quantitative Chemical Analysis, Prentice Hall.
- Wilson, K.; Walker, J. (2000),Principles and Techniques of Practical Biochemistry, Cambridge University Press. Additional Resources:
- Holme, D.J.; Peck, H. (1998),Analytical Biochemistry, Prentice Hall.
- Freifelder, D. (1983),Physical Biochemistry, W.H.Freeman & Company.
- Plummer, D.T.(2001),Introduction to Practical Biochemistry, McGraw-Hill.

Additional Resources:

- Holme, D.J.; Peck, H. (1998),Analytical Biochemistry, Prentice Hall.
- Freifelder, D. (1983), Physical Biochemistry, W.H.Freeman & Company.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions

Assessment Methods:

- Class Tests at Periodic Intervals.
- Written assignment (s) / Presentation by individual students
- End semester University Theory and Practical Examination

Keywords: Column Chromatography, Electrophoretic Techniques

11.1.11. Course Code: DSC11: CHEMISTRY-4 (C4)
Course Title: Functional Group Organic Chemistry-I
Total Credits: 04 (Credits: Theory-02, Practical-02)
(Total Lectures: Theory- 30, Practical-60)

Objectives: To establish the concept, structure, methods of preparation and reactions for the following classes of compounds: alkyl and aryl halides, alcohols, phenols and ethers, aldehydes and ketones are described. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Learning Outcomes:
By the end of the course, the students will be able to:

- Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reaction mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, and electrophilic substitution.

Unit I: Alkyl and Aryl Halides

A) Alkyl halides (upto 5 carbons):

Structure of haloalkanes and their classification as 1°, 2° & 3°.

Preparation: starting from alcohols (1°, 2° & 3°) and alkenes with mechanisms.

Reactions: Nucleophilic substitution reactions with mechanism and their types (SN^1, SN^2 and SNi), Competition with elimination reactions (elimination vs substitution), nucleophilic substitution reactions with specific examples from hydrolysis, nitrite and & nitro formation, nitrile & isonitrile formation and Williamson's ether synthesis.

Grignard reagent and its synthetic applications

B) Aryl halides:

Structure and resonance
Preparation: Methods of preparation of chloro, bromo & iodo-benzene from benzene (electrophilic substitution), from phenols (nucleophilic substitution reaction) and from aniline (Sandmeyer and Gattermann reactions).
Reaction: Nucleophilic aromatic substitution by OH group (Bimolecular Displacement Mechanism), Effect of nitro substituent on the reactivity of haloarenes, Reaction with strong bases $NaNH_2/NH_3$(elimination-addition mechanism involving benzyne intermediate), relative reactivity and strength of CX bond in alkyl, allyl, benzyl, vinyl and aryl halides.

(Lectures: 14)

Unit II: Alcohols, Phenols, Ethers (Aliphatic and Aromatic)

A) **Alcohols (upto 5 Carbon):**

Structure and classification of alcohols as 1°, 2° & 3°.

Preparation: Methods of preparation of 1°, 2° & 3° by using a Grignard reagent, ester hydrolysis and reduction of aldehydes, ketones, carboxylic acids and esters.

Reactions: Acidic character of alcohols and reaction with sodium, with HX (Lucas Test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic $K_2Cr_2O_7$ and conc. HNO_3), Oppeneauer Oxidation.

B) **Diols** (upto 6 Carbons): Oxidation and Pinacol-Pinacolone rearrangement.

C) **Phenols**: acidity of phenols and factors affecting their acidity.

Preparation: Methods of preparation from cumene, diazonium salts and benzene sulphonic acid.

Reactions: Directive influence of OH group and Electrophilic substitution reactions, viz. nitration, halogenation, sulphonation, Reimer-Tiemann reaction, Gattermann–Koch reaction, Houben-Hoesch condensation, reaction due to OH group: Schotten-Baumann reaction

D) **Ethers** (Aliphatic & Aromatic):

Williamson's ether synthesis, Cleavage of ethers with HI

E) **Aldehydes and ketones (Aliphatic and Aromatic):**

Preparation: from acid chlorides and from nitriles.

Reactions: Nucleophilic addition, nucleophilic addition – elimination reaction including reaction with

HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol Condensation, Cannizzaro's reaction,

Wittig reaction, Benzoin condensation, Clemmensen reduction, Wolff Kishner reduction, Meerwein-PondorffVerley reduction.

(Lectures: 16)

PRACTICALS (Credits: 02, Laboratory Periods: 60)

Systematic qualitative identification and derivative preparation of organic compounds. following functional groups containing compounds should be provided: alcohols, phenols, carbonyl compounds and carboxylic acids (mono- and dicarboxylic both). (*Provide few organic compounds containing at least one extra element*)

REFERENCES:

Theory:

- Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7 th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. (2002), Organic Chemistry (Volume 1), 6 th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K. International.
- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2017), Organic Chemistry, 12th Edition, Wiley

Practical:

- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook

of Practical Organic Chemistry, Pearson.
- Mann, F.G.; Saunders, B.C.(2009), Practical Organic Chemistry, Pearson Education.
- Dhingra,S; Ahluwalia V.K., (2017), Advanced Experimental Organic Chemistry, Manakin Press.

Teaching Learning Process:

- Conventional chalk and board teaching
- Class interactions and discussions
- Power point presentation on important topics.
- Teaching Learning process is largely student focused

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory Examination Presentations by Individual Student/ Group of Students

Keywords: Aryl halides, Alcohols, Phenols, Ethers and Epoxides, Aldehydes and Ketones.