SEMESTER II

11.1.4. Course Code: DSC4: ANALYTICAL CHEMISTRY2 (AC2)
Course Title: SEPARATION METHODS-I

Total Credits: 04 **(Credits: Theory-02, Practical-02)**
(Total Lectures: Theory- 30, Practical-60)

Objectives: To acquire basic knowledge of the analytical chemistry of important techniques that will provide the basis for their industrial production methods. To provide an adequate mastery of analytical methods used for the determination of commercial/domestic raw materials and finished product quality.

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

• Become familiar with fundamental concepts of partition coefficients and their role in achieving separations across different types of chromatography.

• Develop the core skills to parse existing chromatographic protocols and identify the key factors influencing a chromatography experiment.

• Understand the underlying assumptions of the most common chromatographic separation techniques and approaches to method validation.

• Understand the concept of solubility and their application in separation using distribution law.

Unit 1: Chromatography

Classification of chromatographic methods: Principles of differential migration, description of chromatographic process, distribution coefficients, modes of chromatography. the chromatography (elution time and volume) capacity factor, column efficiency and resolution, sample preparation.

(Lectures: 08)

Unit 2: Techniques of paper chromatography

Experimental modifications, various modes of developments, nature of paper, detections of spots, retardation factors, factors that affect reproducibility of R_f values (due to paper, solvent system, sample, development procedures), selection of solvent, quantitative analysis, applications.

(Lectures:06)

Unit 3: Thin layer chromatography

Stationary phase, adsorbents, liquid phase support, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot, R_f values (effect of adsorbent, solvent, solute, development process), quantitative analysis, applications.

(Lectures: 05)

Unit 4: Solvent Extraction

Distribution law, determination of distribution ratio, batch extraction, continuous extraction, discontinuous extraction, counter-current extraction.

(Lectures: 05)

Unit 5: Dialysis and membrane filtration

General laboratory methods, filters-nitrocellulose, fiberglass and polycarbonates.

(Lectures: 06)

PRACTICALS (Credits: 02, Laboratory Periods: 60)

1. Separation and identification of amino acids present in the given mixture by **radial** and **ascending** paper Chromatography (*Perform both*).
2. Separation of ortho-nitrophenol & para-nitrophenol and *o*- and *p*-amino phenol by thin layer chromatography (TLC) and calculation of their R_f values.
3. Separation of constituents of leaf pigments by thin layer chromatography and paper chromatography (*radial & ascending both*).
4. Separation of a mixture of compounds by solvent extraction.
5. Separation of a mixture of naphthalene, benzoic acid and 2-naphthol.
6. Separation of a mixture of 1,4-dimethoxybenzene, 2-chloro benzoic acid and *p*-cresol.
7. Analysis of soil samples (*at least three soil samples to be collected for analysis*) collected from college nursery, sports ground Delhi villages/ Yamuna River bank.

   (**a**) Determination of pH of soil samples.

   (**b**) Determination of total soluble salts.

   (**c**) Determination of carbonate and bicarbonate.

   (**d**) Determination of calcium, magnesium and iron.

   (**e**) Determination of conductance of the soil samples.
8. Industrial visit to STP plant.

REFERENCES:

- Fifield,F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
- Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.
- Harris, D. C. (2007), Quantitative Chemical Analysis, 6th Edition, Freeman

- 4. Mikes, O. (2000), Laboratory Handbook of Chromatographic methods, D.Van Nostrand Company Inc.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

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

Keywords: Solvent extraction, TLC, Chromatography.

11.1.5. Course Code: DSC5: CHEMISTRY-2 (C2)
Course Title: PERIODIC PROPERTIES AND CHEMICAL BONDING

Total Credits:4 (Credits: Theory-02, Practical-02)
(Total Lectures: Theory- 30, Practical-60)

Objectives: The course discusses the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry. It provides basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases. It provides an overview of hydrogen bonding and van der Waal forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds.

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

- Understand periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Understand variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Understand the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Understand and draw MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand the importance and applications of hydrogen and van der Wall bonding.

Unit I: Periodic Properties

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes

(Lectures: 12)

UNIT II: Bonding in coordination compounds

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.
Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.
Metallic Bonding, Hydrogen Bonding, van der Waals Forces

(Lectures: 18)

PRACTICALS (Credits: 02; Laboratory Periods: 60)

1. Preparation of standard solutions of different normality and molarity of Mohr's salt and oxalic acid.
2. Estimation of free alkali present in different soaps and detergents (*At least two samples to be taken*).
3. Estimation of oxalic acid by titrating it with $KMnO_4$ (*Provide at least two unknown solutions*).
4. Estimation of Mohr's salt by titrating it with $KMnO_4$ (*Provide a tleast two unknown solutions*).
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} and Ni^{2+}, Co^{2+}.

REFERENCES:

Theory:

- Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education
- Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), Inorganic Chemistry 2nd Ed., Oxford University Press.
- Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Inorganic Chemistry, 5th Edition, W. H. Freeman and Company.

- Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India
- Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
- Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
- Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.

Practical:

- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

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

Keywords: Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Ionic Bonding, Dipole Moment, VSEPR Theory, Covalent Bonding, Metallic Bonding, van der Wall Forces.