11.2.8. Course Code: CHEMISTRY (DSE-C2)
Course Title: CONDUCTANCE, ELECTROCHEMISTRY AND CHEMICAL KINETICS

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

Objectives: In electrochemical cells the students will learn about electrolytic and galvanic cells, measurement of conductance and its applications, measurement of emf and its applications. The student will also learn about the reaction rate, order, activation energy and theories of reaction rates.

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

- Explain the factors that affect conductance, migration of ions and application of conductance measurement.
- Understand the importance of Nernst equation, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements.
- Understand rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.

Unit 1: Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Arrhenius theory of electrolytic dissociation, Kohlrausch Law of independent migration of ions, Ionic velocity, mobility and their determination, transference number and its relation to ionic mobility, determination of transference number using Hittorf and Moving Boundary methods. Applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

(Lectures: 08)

Unit 2: Electrochemistry

Review of reversible and irreversible cells, standard electrode potential, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells, liquid junction potential and salt bridge, pH determination using hydrogen electrode and quinhydrone electrode, Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

(Lectures: 12)

Unit 3: Chemical Kinetics and Catalysis

The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants), half–life of a reaction, general methods for determination of order of a reaction, Concept of activation energy and its calculation from Arrhenius equation. Theories of reaction rates: Collision theory and activated complex theory of bi-molecular reactions. Comparison of the two theories (qualitative treatment only) Catalysis: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

(Lectures:10)

PRACTICALS (Credits :2; Laboratory Periods: 60)

Conductance

1. Determination of molar conductance, degree of dissociation and dissociation constant of a weak acid.
2. Perform the following conductometric titrations: **a**) Strong acid *vs* strong base **b**) Weak acid *vs* strong base. **c**) Mixture of strong acid and weak acid *vs.* strong base.

Potentiometry

3. Perform the potentiometric titrations of
   a) Strong acid vs strong base
   b) Weak acid vs strong base.
   c) Potassium dichromate vs. Mohr's salt Chemical Kinetics
4. Study the kinetics of acid hydrolysis of methyl acetate with hydrochloric acid.
5. Study the kinetics of Iodide-persulphate reaction by Initial rate method or integrated rate law method.
6. Effect of substrate concentration on acid phosphatase activity and determination of its K_m, V_{max} and K_i (with respect to inorganic phosphate).

REFERENCES:

Theory:

- Castellan, G. W .(2004),P hysical Chemistry, Narosa.
- Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.1, 6th Edition, McGraw Hill Education.
- Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.5, 3rd Edition, McGraw Hill Education.
- Puri, B.R., Sharma, L.R. and Pathania M.S. (2020), Principles of Physical Chemistry, Vishal Publishing Co.

Practical:

- Khosla, B.D.; Garg, V.C.; Gulati, A.(2015), Senior Practical Physical Chemistry, R. Chand & Co.
- Kapoor, K.L. (2019), A Textbook of Physical Chemistry, Vol 7, 1st Edition, McGraw Hill Education.

- Batra, S.K., Kapoor, V and Gulati, S. (2017) 1 st Edition, Experiments in Physical Chemistry, Book Age series.

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: Rate law, Order of reaction, Activation Energy, Conductance, Transference Number, Electrode potential, Electrochemical series.

11.2.9. Course Code: CHEMISTRY (DSE-C3)
Course Title: PHASE EQUILIBRIUM AND SOLUTIONS

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

Objectives: The students will gain an understanding of phase, co- existence of phases, phase diagram, CST and distribution law and its applications.

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

- Understand phase equilibrium, criteria, CST, Gibbs-Duhem-Margules equation.
- Apply the concepts of phase and its applications in purification etc.
- Learn about distribution law and its importance in solvent extraction.

Unit 1: Phase Equilibria

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria,
Phase diagram for one component systems (H_2O, CO_2 and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Phase diagram of three component system, Triangular plots, water-chloroform-acetic acid system.
Application of phase in explaining phenomenon in everyday life.

(Lectures: 15)