

Course Code	Course Name	Credits
26CH507	ELECTROCHEMISTRY AND STATISTICAL THERMODYNAMICS	04

Course Objectives

- To understand the principles of electrochemical cells, conductivity, and ionic equilibrium.
- To apply electrochemical and thermodynamic concepts for calculating EMF, pH, and equilibrium properties.
- To analyze statistical thermodynamics concepts and relate microscopic behavior to macroscopic properties.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Enumerate the basics of electrolytic processes.
- Describe the concept electrode potential.
- Understand the concept of salting out constant and learn the concepts and measurement of equivalent conductance.

Unit 1 - Electrochemical cells (15 Hrs.)

Electrode Potentials - The Standard Hydrogen Electrode; Types of Electrodes and their Potentials; Nernst Equation; EMF calculation and measurement of cell EMF; Single electrode potential; Determination and meaning of electrode potentials; Electrochemical voltage series; Electrical conduction; Conduction in metals and in electrolytic solutions; Measurement of conductivity in electrolyte solutions; Migration of ions; Determination of Transport Numbers; Kohlrausch's law; Arrhenius theory of electrolytic dissociation; Ostwald's law of dilution; Theory of strong electrolytes-Debye-Huckel-Onsagar theory; Wien-Effect.

Unit 2 – Conduction Measurement and Electromotive Force (13 Hrs.)

Applications of conductance measurements; Determination of the degree of dissociation; Determination of K_a of acids; Determination of the solubility of poorly soluble salts; Conductometric titrations (acid-base and precipitation); Electrochemical cell; electrolytic cell; reversible and irreversible cells; Weston cadmium standard cell; Calculation of the EMF of the cell; Relationship between free energy and EMFG; temperature dependence of the cell; thermodynamic parameters of cell reactions.

Unit 3 - Ionic Equilibrium (12 Hrs.)

Solubility and solubility product-determination of solubility product; Applications of solubility product principle; Dissociation of weak acids and bases; Dissociation constants; pH scale; buffer solutions; Determination of pH values of buffer mixtures; Henderson's equation; Hydrolysis of salts; Degree of hydrolysis.

Unit 4 – Statistical thermodynamics-I (10 Hrs.)

Thermodynamic probability; Probability theorems; Relation between entropy and probability (Boltzmann-Planck equation); Ensembles; Phase space; Ergodic hypothesis; Microstates and Macro states; Maxwell-Boltzmann distribution law; Partition functions: translational, rotational, vibrational and electronic partition functions.

Unit 5 - Statistical thermodynamics-I (10 Hrs.)

Relationship between partition functions and thermodynamic properties; Calculation of equilibrium constants from partition functions; Heat capacities of monatomic crystals; Einstein theory and Debye theory; Quantum statistics; Bose-Einstein (B.E.) and Fermi-Dirac (F.D.) distribution equations; comparison of B.E. and F.D. statistics with Boltzmann statistics; Applications of quantum statistics to liquid helium, electrons in metals and Planck's radiation law; Concept of negative Kelvin temperature.

Reference Books:

- B.R. Puri and L.R. Sharma, Principles of Physical Chemistry, 33rd Edn., 1992, Shoban Lal Nagin Chand and Co.
- S.H. Maron and J.B. Lando, Fundamentals of Physical Chemistry, 1966, Macmillan Limited, New York.
- S.K. Dogra and S. Dogra, Physical Chemistry through Problems, 4th Edn., 1996, New Age International.
- P.W. Atkins, Physical chemistry, 1978, Oxford University Pres.
- K.L. Kapoor, A textbook of Physical chemistry, Vol. 2 & 3, 1994, Macmillan, India Ltd.

Websites and eLearning Sources:

- <https://nptel.ac.in/courses/103103355>
- <https://www.youtube.com/watch?v=txHJDSqZK70&list=PLKQMkzm44qAfmLee3aeuj9s0hyMdVZQb1>

COs and Bloom's Taxonomy Mapping – 26CH507		
Course Outcomes	On completing P.G. program the students will be able to	BTL
CO1	Recall and explain the construction, function, and applications of galvanic cells, electrolytic cells, and fuel cells. Explain standard electrode potentials	K1, K2
CO2	Apply the Nernst equation to calculate cell potentials under non-standard conditions.	K3
CO3	Analyze how microscopic statistical descriptions give rise to macroscopic thermodynamic properties such as internal energy, entropy, and free energy.	K4
CO4	Evaluate experimental data by judging its consistency with principles of electrochemistry and statistical thermodynamics.	K5
CO5	Design innovative strategies to mitigate corrosion and develop new materials by integrating electrochemical and thermodynamic principles.	K6

BTL K1 and K2 – remembering and understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6- Create

Relationship Matrix – 26CH507												
Course Outcomes	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	1	3	2	3	3	1	3	3	3	2	1	2.27
CO2	3	3	3	2	1	2	2	2	3	1	3	2.27
CO3	1	2	2	1	3	1	2	3	1	2	2	1.81
CO4	2	3	1	3	2	2	1	3	2	3	3	2.27
CO5	1	3	3	2	2	3	1	3	3	1	2	2.18
Total											2.16	

Mean Score: 3- High, 2- Medium/Moderate, 1-Low

