Course No.	Course Name	L-T-P-Credits
CY 410	**Surfaces and Electrochemistry**	**3-0-0: 03**
Prerequisite: NIL		

Course Objectives: The main objective of the course is to give knowledge of surfaces and electrochemistry. The course will helped the students to get the insight of colloids, surface chemistry, exploration into kinetics and mechanism of heterogeneous catalysis, futher studies on different surface study techniques The course is designed to gather ideas of elementary electrochemistry and also focused on various modern electrochemical methods, their applications.

Course Outcomes: After successful completion of the course, students will be able to:

1. Understand the basic theories related to colloids, surface chemistry and modern electrochemistry.
2. Distinguish between monolayer adsorption and multiplayer adsorption according to the laws of adsorption.
3. Differentiate quantitatively the adsorption isotherms of Gibbs, Freundlich and Langmuir along with their applications.
4. Analyze the mechanisms of unimolecular and bimolecular reactions at surfaces with respect to the concepts of chemical kinetics.
5. Use various techniques to characterize surface structures of different systems.
6. Distinguish the basic difference between galvanic and electrolytic cell, further understanding related to the representations of cells and concepts of Nernst equation.
7. Evaluate different parameters like ionic product, solubility and solubility product of electrolytes using basic laws related to EMF measurements.
8. Understand the role of electrochemistry in the analysis of corrosion phenomena.
9. Identify the electrochemical energy resources of diverse types.

SYLLABUS

Module	Contents	Hours
I	**Colloids and Surface chemistry** Thermodynamic descriptions of surface, surface tension, capillary action, vapour pressure of droplet. Colloids: introduction, classification and properties; surfactants–definition and classification; micelle formation and determination of critical micelle concentration; reverse micelle and its application and micro-emulsion, gels and foams, nanoparticles. Structure of solid surfaces, adsorption isotherm, shapes of isotherms, Langmuir's theory of adsorption, BET equation, determination of surface area of an adsorbent, thermodynamics of adsorption processes. Kinetics and mechanism of heterogeneous catalysis (Langmuir-Hinshelwood model and Eley-Riedel model). Surface study techniques: Auger electron spectroscopy, XPS, LEED, SERS, STM, AFM, SEXAFS, SEM and SPM.	16
II	**Electrochemistry** Conductance and Ionisation: ionic conductance, molar conductivity, strong and weak electrolytes and their molar conductance, Kohlrausch's law, Ostwald's dilution law, conductometric titrations. Migration of Ions: Ionic mobility, Transport number and its relation with	20

	concentration and ionic mobility, experimental procedures for measuring transport numbers (Hittorf's rule, Moving boundary method), Grotthuss mechanism. Theory of Electrolytic Conductance (qualitative description only): ionic atmosphere, electrophoretic effect - Debye-Hückel-Onsager equation, Effect of high potential gradient (Wien effect) and high frequency (Debye-Falkenhagen effect). Electrodes and electrochemical cells, cell reactions, Nernst equation, varieties of electrodes and standard electrodes. Electrode kinetics, electrode/electrolyte interface, electrical double layer, equilibrium exchange current density, Butler–Volmer Equation, Tafel plot, over potential and activation energy. Corrosion: Different types of corrosion; influence of environment; Evans diagram, Pourbaix diagram; corrosion rate measurements; Stern Geary equation; mixed potential theory and prevention of corrosion. Batteries, solid state batteries and fuel cells. Basic principles and applications of polarography, cyclic voltametry, coulometry, chronopotentiometry and AC impedance techniques.	

Essential Readings:

1. P. Atkins and J. D. Paula, “Atkins' Physical Chemistry”, Oxford University Press, 11th Edition, 2018.
2. B. R. Puri, L. R. Sharma and M. S. Pathania, “Principle of Physical Chemistry”, Vishal Publishing Co., 46th Edition, 2017.

Supplementary Readings:

1. R. M. Pashley and M. E. Karaman, “Applied Colloid and Surface Chemistry”, John Wiley & Sons Ltd., 1st Edition, 2014.
2. J. O. M. Bockris, “Modern Electrochemistry 2A - Fundamentals of Electrodics”, Springer, 1st Edition, 2018.
3. G. Attard and C. Barnes, “Surfaces”, Oxford Science Publications, 1st Edition, 1998.
4. H. H. Willard, L. L. Merritt and J. A. Dean, “Instrumental methods of analysis”, CBS Publishers & Distributors Pvt. Ltd., 7th Edition, 2004.