

**Course Title: Advanced Electrochemistry****Course Code: CH-824**Credit Hours: **3-0****Prerequisite: Nil****Course Objectives**

To learn the principles, mechanisms and kinetics of the charge transfer at the electrode-electrolyte interface. To study the properties of the materials to evaluate their electrochemical behaviors.

**Course Outcomes**

Student will have the hand on analysis of the experimental data obtained from their experiments. In depth knowledge in term of kinetics and mechanisms can be done.

**Course Contents: Properties of the electrode-solution interface:** Interface electrode-solution, Type of the electrodes, The electrochemical potential, Internal, external, and surface potentials, Distribution of energy levels, Two metals in contact, Metal-solution interface, Absolute electrode potential, Absolute potential of the standard hydrogen electrode. **Potentiometry**, Activity, Debye-Hückel theory of ion-ion interactions, Limiting Debye-Hückel theory, Influence of the ionic radius, Electrode potentials, Nernst equation, Formal potentials  $E_0'$ , Types of the electrodes, Electrodes of the first kind, Electrodes of the second kind, Electrodes of the third kind, Redox electrodes, Concentration cells, Primary and secondary batteries, Reference electrodes, Determination of the standard electrode potential, Potentiometric determination of the activity and activity coefficients. **Physicochemical methods of determination of the activity coefficients:** From osmotic coefficient, From changes of the boiling or freezing point, Determination of the equilibrium constants, Complex formation equilibria. **Double layer thermodynamics**, Gibbs adsorption isotherm, The electrocapillary equation, Experimental determination of the double layer parameters, Experimental results for the thermodynamic double layer studies, Adsorption criteria, Adsorption isotherms, Langmuir isotherm, Frumkin isotherm, Temkin isotherm, Experimental adsorption isotherms, **Helmholtz model of Charge Double layer**, **Fundamentals of the electrode kinetics:** Potential dependence of the electrode kinetics, Influence of the double layer on the electrode kinetics; Frumkin relation, Formal kinetics of electrode reactions.

**Properties of the electrode-solution interface:** Interface electrode-solution, Type of the electrodes, The electrochemical potential, Internal, external, and surface potentials, Distribution of energy levels, Two metals in contact, Metal-solution interface, Absolute electrode potential, Absolute potential of the standard hydrogen electrode. **Electrode Kinetics;** Kinetics of electron transfer, Current over-potential relation, Butler-Volmer equation. **Applications:** batteries, fuel cells.

### **Recommended Books**

1. [Andrzej Lasia](#), Advanced Electrochemistry. Interfaces, thermodynamics, and electrochemical techniques, Jan. (2018)
2. Atkins, P. and Paula, J. D., Atkin's Physical Chemistry, 9th ed., Oxford University Press, (2010).