Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NCYD525	Advanced Electrochemistry	3	0	0	3

Course Objective
• The learners should be able to apply theories in electrochemistry to analyze electrode kinetics.
Learning Outcomes
At the end of the course, the learners should be able to: • Write equations representing electrochemical cell, explain various overpotential involved during the operation of the cell. • Calculate electrochemical cell parameters, electrochemical active surface area, current and overpotential under given condition, Plot potential vs current, surface coverage vs. potential, potential vs. pH, concentration profile vs. distance from the electrode. • Understand the basics of electrocatalysis and industrial applications of electrochemistry

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Ionics: Electrochemistry of solutions, Ion-solvent interactions, ion-ion interactions, ionic migration and diffusion. Phenomenological description of transport processes. Electrodics: Equilibrium electrode potentials, Thermodynamics of electrochemical cells and applications.Theories of Double-Layer structure, diffuse-double-layer theory of Gouy and Chapman, the Stern Model, Adsorption of ions and neutral compounds	12L	Students will able to understand the: classification of substances as conductors or non-conductors Distinguish between metallic and electrolytic conduction Learn electrolysis, cathode, anode, cation and anion Learn electrolytes as strong and weak based on their conductivity Predict the electrode to which an ion will drift Learn oxidation and reduction reactions including reactions at electrodes Predict chemical reactions making use of electrochemical series Identify ions present in electrolytes Able to perform the electrolysis of certain substances Understand Faraday constant and industrial applications of electrolysis
2	Electrode kinetics: Current-potential relationship (derivation of Butler-Volmer and Tafel equations). Adsorption isotherms for intermediates formed by charge transfer (Langmuir adsorption and its limitations, relating bulk concentration to surface coverage), Electrocaplillary and differential capacitance measurements; Influence of double layer on charge transfer processes.potential of zero charge, pzc of solid electrodes, polarization: types of polarization, the charge transfer	16L	After completing the course you should be able to: Better knowledge in electrode kinetics, including both theories and experimental techniques for kinetic investigations. Describe what information you can get when using these techniques and also their limitations. Explain how to use the techniques and how to determine electrochemical parameters from experimental data. Evaluate which technique that is most suitable for a certain electrochemical system and when searching for specific parameters.

	resistance Types of overpotentials: origin and minimization		Describe the theories behind electro capillary and capacitance measurements.
3	Electro-catalysis, Bio-electrochemistry, Electron transfer in homogeneous system and in heterogeneous system. Electrosynthesis: electroorganic and electroinorganic syntheses, mechanism of electro-organic reactions; hydrogen evolution and oxygen reduction reactions, Industrial processes: electroplating, anodization, Al production, electrosynthesis of selected industrial chemicals.	14L	After completing the course, the students can: Demonstrate the knowledge of the principles and key applications of electro-catalysis. Explain the relation and difference between electrocatalysis in various disciplines. Explain the interdisciplinary connection of electrocatalysis with materials and surface science. Explain the different catalyst preparation procedures. Explain the use of electro- catalysis and modern catalyst characterization methods Identify and understand the latest knowledge connected to industry based electro-catalysis research.

Text Books:

1. J. Bard and L. R Faulkner Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Wiley, 2001

Reference Books:

1. Atkins' physical chemistry, P. Atkins and J. de Paula, 8th Edition, Oxford University Press, New Delhi, 2008.
2. Gileadi, Physical Electrochemistry, Fundamental, Techniques and Applications, Wiley-VCH, 2011