

# 20CY212 INDUSTRIAL ELECTROCHEMISTRY AND BATTERIES

Hours Per Week :

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## Course Description and Objectives:

This course covers the basic theory and application of electrochemistry. It is targeted toward students who want to better understand electrochemical processes or to add electrochemical methods to their repertoire of research approaches, including both those who have not yet had much formal electrochemical training and those with more experience. The course starts at a basic level to ensure that each student starts on a solid footing and to dispel common misconceptions. It then progresses to cover the core of electrochemical theory that forms the basis for the techniques that are detailed later in the course. Practical examples, diagrams and images illustrate and reinforce the subject matter.

## Course Outcomes:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes
1.	Formulate equations representing electrochemical cell and construct various reference electrodes using electrochemistry concepts.
2.	Analyze various over potential involved during operation of the cell to understand the kinetics of electrochemical reactions.
3.	Apply the knowledge of electrochemistry to analyze real-time electrochemical processes using various experimental techniques.
4.	Evaluate various electrochemical energy conversion/storage systems by applying the basic electrochemistry principles.
5.	Analyze various factors effecting corrosion and apply proper corrosion control and prevention methods.

**Unit – I :****Fundamental Measurements in Electrochemistry :**

Types of cells, cell components, Nernst equation, electrical double layer, equilibrium electrode potential, ion-solvent interaction, IUPAC convention of electrode potentials, electrochemical series, thermodynamics of electrochemical cells and applications, Polarizable and non-polarizable electrodes, types of reference and working electrodes, cell geometry, choice of reference electrodes.

**Unit – II:****Electrode Kinetics :**

Current-potential relationship using Butler-Volmer and Tafel equations, types of overpotential and their minimization, types of diffusion of electroactive species, hydrogen evolution reaction, oxygen evolution/reduction reaction, transition state theory and Gibbs free energy of activation.

**Unit – III :****Experimental Techniques :**

Cyclic voltammetry, Linear sweep voltammetry, chronopotentiometry, chronoamperometry, electrochemical impedance spectroscopy, Nyquist and Bode plot, Randle's circuit, resistance, capacitance, inductance, constant phase element, fitting of impedance spectra with suitable circuit.

**Unit – IV :****Energy Conversion/Storage Systems :**

Fuel cells (hydrogen-oxygen and methanol-oxygen, proton exchange membrane fuel cell), Batteries (primary and rechargeable batteries): Lead-acid battery, lithium ion battery, Zn-air battery, Photo-electrochemical cells, supercapacitor, and dye-sensitized solar cells.

**Unit – V:****Corrosion and its Control :**

The fundamental electrochemistry of corrosion, scope and economics of corrosion, different types of corrosion, influence of environment, Evans diagram, Pourbaix diagram (potential vs. pH), corrosion rate measurements, Stern Geary equation, mixed potential theory and prevention of corrosion. Pitting corrosion, localized corrosion, bimetallic (Galvanic) corrosion, cathodic protection, anodic protection, coatings and inhibitors.

**Text Books:**

1. Gileady, Physical Electrochemistry, Fundamental, Techniques and Applications, Wiley-VCH – 2011.
2. J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2<sup>nd</sup> Edition, Wiley 2001.

**Reference Books:**

1. H. Reiger, Electrochemistry, 2<sup>nd</sup> Edition, Springer 1994.
2. Newman and K. E. Thomas-Alyea, Electrochemical Systems, 3<sup>rd</sup> Edition, Wiley Interscience, 2004.
3. J. Wang, Analytical Electrochemistry, 2<sup>nd</sup> Edition, Wiley-VCH, A. John Wiley & Sons, Inc., Publication, 2000.
4. M. E. Orazem and B. Tribollet, Electrochemical Impedance Spectroscopy, A. John Wiley & Sons, Inc., Publication, 2008.