

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
HYDERABAD CAMPUS
FIRST SEMESTER 2021-2022
Course Handout (Part II)

Date: 01/08/2021

In addition to part -I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : CHE G556
Course Title : Electrochemical Engineering
Instructor-in-charge : Afkham Mir
Tutorial Instructors : Afkham Mir

Description : Basic physics of galvanic cells, Electrochemical Energy conversion, Electrochemical Energy storage, Equivalent circuit dynamics, Impedance spectroscopy, Impedance of electrodes, Nernst equation, Fuel cells and batteries, Faradic equations in dilute solutions, Butler Volmer equation, Reactions in concentrated solutions, Ion absorption and intercalation, Concentration polarization, forced convection in fuel cells, Transient diffusion, Warburg impedance, Diffusion in concentrated solutions, Transport in bulk electrolytes, Ion concentration polarization, Double layer structure, Transport on porous media, Porous electrodes, Super capacitors, Electrostatic correlations

1. Scope and Objective of the Course:

The objective of the course is to teach the students the basics of electrochemical engineering and electrochemistry. By the end of the course, the students should be able to understand the theoretical and experimental functioning of batteries, fuel cells, electrodeposition and other electrochemical systems.

2. Learning Outcomes:

- 1) Understand the experimental techniques in electrochemical systems.
- 2) Understand the theoretical background behind electrochemical systems.
- 3) Understand the usage and applications of electrochemical systems.

3. Text Book:

Electrochemical Engineering, Thomas Fuller and John Harb, Wiley.

4. Reference Books:

Electrochemical methods, Bard and Faulkner

Electrochemical Systems, John Newman and Karen Thomas.

5. Course Plan:

Lec No	Learning Objectives	Topics to be covered	TB/Ref.Book
1-2	Introduction to Basic Principles	Electrochemical cells, Faraday's law	Chapter 1
3-5	Cell Potential Thermodynamics	Cell Potential Equilibrium constants	Chapter 2
6-10	Electrochemical Kinetics	Butler Volmer Kinetics	Chapter 3
11-15	Transport	Nernst Planck Equations	Chapter 4

16-19	Electrode Structures and Configurations	Porous Electrodes, Three-Phase Electrodes	Chapter 5
20-26	Electroanalytical Techniques	Cyclic voltammetry, Impedance	Chapter 6
27-31	Battery fundamentals	Battery principles	Chapter 7
32-35	Electrochemical double layer capacitors	EDLC electrodes	Chapter 11
36-37	Industry applications	Electrolysis, electroplating	Chapter 14
38-40	Semiconductor Electrodes	Photoelectrochemical Cells, Interfaces	Chapter 15

2. Plan for lab Experiments

Experiment No	Lab name	Experiment Name
Expt-1	Instrumentation lab	Introduction to various Reference Electrodes
Expt 2	Instrumentation lab	Modelling the Butler-Volmer Equations -I
Expt-3	Instrumentation lab	Modelling the Butler-Volmer Equations –II
Expt-4	Instrumentation lab	Performing Linear Sweep Voltammetry
Expt-5	Instrumentation lab	Performing Cyclic Voltammetry
Expt-6	Instrumentation lab	Performing Electrochemical Impedance Spectroscopy
Expt-7	Instrumentation lab	Analyzing the Electrochemical Impedance Spectroscopy Data -I
Expt-8	Instrumentation lab	Analyzing the Electrochemical Impedance Spectroscopy Data -II
Expt-9	Instrumentation lab	Performing CV to calculate the ECSA -I
Expt-10	Instrumentation lab	Performing CV to calculate the ECSA -II
Expt-11	Instrumentation lab	Testing the supercapacitance-Calculating specific capacitance –I
Expt 12	Instrumentation lab	Testing the supercapacitance-Calculating specific capacitance –II

3. Evaluation Scheme:

Component	Duration	Weightage	Date & Time	Remarks
Mid Semester	90 min	25%	22/10 11:00 am-12:30 pm	OB
Quizzes (Q1, Q2, Q3)	TBA	15%	TBA	OB
Assignment (A1)	TBA	15%	TBA	OB
Lab Component	TBA	10%	TBA	OB
Comprehensive	120 min	35%	22/12	OB

*TBA: to be announced

7. Chamber Consultation Hour: 3.00-4.00 pm. (Chamber: D 319)

8. Notice: Notice will be displayed on Chemical Engineering Notice Board or CMS

9. Make-up policy: Make-up will be granted after he /she maintains minimum 60 % attendance in the class. Certificate from authenticated doctor from the Medical Center must accompany make-up application and follow the ID guidelines for midterm and compre exams.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge
Dr. Afkham Mir