Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2021-2022

Course Handout (Part - II) Date: 15-01-2022

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. : CHEM F327
Course Title : **Electrochemistry: Fundamentals and Applications**
Instructor-in-Charge : Dr. Durba Roy
Co-Instructor : -

Scope and Objective of the Course:
The course aims at covering fundamental topics in electrochemistry, with broad classification of the entire subject into the domains viz., electrode processes, electron-transfer kinetics, mass transfer, voltammetry, impedance etc. Starting with the fundamental principles and their applications, the ultimate purpose of this course is to provide a comprehensive survey of different areas e.g. Photovoltaics, Electro-catalysis, Electro-sensors, Corrosion etc. for industry and academic research in the field of electrochemistry. Different electrochemical instruments will be covered to provide structural information about the electrode and surface microscopic methods.

Textbooks:
1. A. J. Bard and L. R. Faulkner 'Electrochemical Methods: Fundamentals and Applications', 2nd Edition, (John Wiley & Sons, Inc., Copyright 2001).

Reference books
1. Bard, A. J., Ed., (from Vol. 19 with I. Rubinstein), "Electroanalytical Chemistry," Marcel Dekker, New York, 1966-1998.
2. Bockris, J. O'M., and B. E. Conway, et al., Eds., "Modern Aspects of Electrochemistry," Plenum, New York, 1954-1997.

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Learning Outcomes	Chapter in the Text Book
1-3	Introduction and Overview of Electrode Processes	Electrochemical cells and reactions, working, reference, and counter electrode, electrolyte, overpotential, Faradaic and non-Faradaic Processes, capacitance, electrical double layer, and double-layer capacitance	Apply oxidation-reduction concepts to electron transfer process in electrochemical systems. Relate electrode reactions with electrode potentials and vice versa.	Ch: 1, p.2-17

4-6	Electrochemical Cells	Primary and secondary cells, various electrochemical experiment, factors affecting electrode reaction, cell resistance, mass transfer, coupled reversible and irreversible reactions	Demonstrate reactions taking place in different electrochemical cells, analyze factors affecting the EMF of the cells.	Ch: 1, p.18-30, p.36-38
7-9	Potentials and Thermodynamics of Cells	Electrochemical thermodynamics, cell EMF, formal potentials, electrochemical potential, liquid junction potentials, conductance, mobility, junction of two immiscible liquids, and selective electrodes	Apply thermodynamic principles to calculate cell EMF and liquid junction potentials	Ch: 2, p.44-53, p.60-68, p.73-79
10-13	Kinetics of Electrode Reactions	The Arrhenius equation and potential energy surfaces, transition state theory, electrode reactions, kinetics, Butler-Volmer model, implications of the Butler-Volmer model, and Tafel plots	Explain factor affecting electrode kinetics, demonstrate electrode kinetics with Butler-Volmer analytical model	Ch: CH:3, p.88-100, p.103
14-15	Multistep Mechanism	Electron transfer in rate-determining step, quasireversible and irreversible multistep process, charge transfer, and Marcus theory	Interpret fundamentals of electron transfer process using Marcus theory	Ch: 3, p.107-124
16-19	Mass Transfer by Migration & Diffusion	General mass transfer equation, migration, diffusion, and Fick's laws of diffusion	Outline electrode kinetics by mass transfer and diffusion	Ch: 4, p.137-139, p.146-150
20-22	Basic Potential Step Methods	Overview, detection, potential step under diffusion control, idea of ultramicroelectrodes (UME)	Select electrodes for different measurements	Ch: 5, p.156-161, p.168-170, p.207- 217
23-25	Potential Sweep Methods	Introduction, reversible system, peak current and potential, irreversible system, quasi-reversible system, cyclic voltammetry (CV), and multicomponent system	Illustrate CV technique, Analyze electrode process using voltammetry	Ch: 6, p.226-231, p.234-240, p.243 (partly self-study)
26-29	Concepts of Impedance	Various types, Faradaic impedance, kinetic parameters, electrochemical impedance, cyclic ac voltammetry, instrument for impedance	Interpret effects due to Faradaic impedance	Ch: 10, p.368-370, 377, 398, 406
30-31	Instrumentation:	Potentiostats, Scanning tunneling microscopy (STM), scanning electrochemical microscopy (SECM), its applications	Explain basic principle or operating STM, SECM, AFM	Ch: 15 & 16, p.640 (partly ss) p.659-676
32-35	Applications: Photoelectrochemistry and ECL	Photoelectrochemistry, Electron transfer at semiconductors, semiconductor electrodes, photoeffects, photovoltaic cells	Explain basic principles of photo-electrochemistry and photovoltaic cells	Ch: 18, p.736-743, p.745-760, Class notes, self-study
36-40	Applications: medical device, electroplating and corrosion	Applications of electrochemistry in medical technology and diagnostic devices, electroplating and prevention to corrosion	Outline application of electrochemical methods for industrial applications	Class notes, self-study

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid-Semester Test	1.5 hrs	35	10/03 11.00am to12.30pm	Closed Book
Comprehensive Exam	2 hrs	40	06/05 AN	Closed Book
Class Assignment	Continuous	25	TBA	Open Book

Chamber Consultation Hour: will be announced later.

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.

Notices: Notices, if any, concerning the course will be displayed on CMS.

Make-up Policy: Make up would be considered only for genuine reasons.

Instructor-In charge

Durba Roy