BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION
FIRST SEMESTER 2016-2017
COURSE HANDOUT (PART-II)

Date: 02/08/2016

In addition to part I (General handout for all courses appended to the timetable) this portion gives further details regarding the course.

Course No. : **CHEM F327**
Course Title : **Electrochemistry: Fundamentals and Applications**
Instructor-in-charge : **SUROJIT PANDE**

1. Course Description: The course provides a detailed idea about electrochemistry and electroanalytical chemistry. An overview of electrode processes, electron-transfer kinetics, and mass transfer will be discussed in this course. Concepts from these basic areas are integrated together in treatments of the various methods in electrochemistry. Finally, different electrochemical instrumentation and application of electrochemistry will be discussed.

2. Scope and Objective of the Course: The course aims at covering topics in electrochemistry, with the broad classification of the entire subject into the domains viz., electrode processes, electron-transfer kinetics, mass transfer, and electrochemiluminescence (ECL). Starting with the fundamental principles and their applications, the ultimate purpose of this course is to provide a comprehensive survey involved in the different areas of electrochemistry before starting formal research in any of the electrochemical areas. Different electrochemical instruments will be covered to provide structural information about the electrode and surface microscopic methods. Finally, an out-line of electrochemistry in industry, bioelectrochemistry, photoelectrochemistry, and ECL will be covered.

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

4. Reference Books:
R1. Christopher M. A. Brett and Ana Maria Oliveira Brett, "ELECTROCHEMISTRY, Principles, Methods, and Applications", Oxford University Press, 1993.
R2. John O'M. Bockris and Amulya K. N. Reddy, "Modern Electrochemistry" Volume 1, 2nd edition, Springer, 2006.

5. Course Plan:

L. N.	Topics to be covered	Learning objectives	Reference to text book
1-4	Introduction and Overview of Electrode Processes	Electrochemical cells and reactions, working, reference, and counter electrode, electrolyte, overpotential, Faradaic and nonfaradaic Processes, capacitance, electrical double layer, and double-layer capacitance	Ch: 1, p.2-17

5-8	Electrochemical Cells	Primary and secondary cells, various electrochemical experiment, factors affecting electrode reaction, cell resistance, mass transfer, coupled reversible and irreversible reactions	Ch: 1, p.18-30, p.36-38
9-12	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	Ch: 2, p.44-53, p.59-79
13-16	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	Ch: 3, p.88-103
17-19	Multistep Mechanism	Electron transfer in rate-determining step, quasireversible and irreversible multistep process, charge transfer, and Marcus theory	Ch: 3, p.107-124
20-22	Mass Transfer by Migra & Diff	General mass transfer equation, migration, diffusion, mixed migration and diffusion, balance sheets for MT, & Fick's law of diffusi.	Ch: 4, p.137-151
23-24	Basic Potential Step Methods	Overview, detection, idea of ultramicroelectrodes (UME) & appl. of UME	Ch: 5, p.156-161, p.168-176, 216
25-27	Potential Sweep Methods and Idea of Impedance	Introduction, peak current and potential for reversible and irreversible system, Faradaic impedance and electrochemical impedance spectroscopy (EIS)	Ch: 6, p.226-236, Ch: 10, p.368-376
28-31	Instrumentation: Scanning Probe Techniques	Potentiostats, Scanning tunneling microscopy (STM), atomic force microscopy (AFM), scanning electrochemical microscopy (SECM), all applications	Ch: 15 & 16, p.640 (partly ss) p.659-676
32-36	Applications: Electrochemistry in Industry, Bioelectrochemistry	Examples of industrial electrolysis and electrosynthesis, electrodeposition, batteries, fuel cells, electrochem in water & effluent treatment, electrochemical interface between biomolecules: cellular & transmembrane poten.	**R1**. Ch: 15 & 17, p.327-350, p.367-374
37-40	Applications: Photoelectrochemistry and ECL	Electrogenerated chemiluminescence (ECL), kinds of experiments, analytical applications of ECL, photoelectrochemistry at semiconductors, semiconductor electrodes, photoeffects, electrochemical detection of photolytic and radiolytic products	Ch: 18, p.736-743, p.745-760

6. Evaluation Scheme:

Component	Weightage%	Date /Time/Venue
Mid Semester Test	25 (Closed Book)	<TEST_1>
Assignments and Quizzes	20	Continuous
Seminar	7.5	
Research paper discussion	7.5	
Comprehensive Exam	40 (20% open book)	<TEST_C>

Assignments: Assignments will be given periodically to supplement the material discussed in class. These assignments will include problem sets. Students will also have to deliver seminars on some topics and electrochemistry based research paper discussion, which will be provided in the class.

Make-Up: Make up would be considered only for **regular students having genuine reasons.** For seminar and research paper discussion there won't be any make-up.

Notice: Notices, if any, concerning the course will be displayed on **Nalanda only.**

SUROJIT PANDE
Instructor-In-Charge
CHEM F327