Programme: M. Sc. Part-II (Chemistry)
Title of the Course: Electrochemistry and Surface Studies
Course Code: PCC-503
Number of Credits:03 **Effective from AY:** 2019-20

Prerequisites for the course:	Should have studied the courses PCC-401, PCC-402 and PCO-401. Should have basic knowledge of Physical Chemistry.	No. of lectures
Course Objectives:	To introduce electrochemical processes such as ion-ion and ion solvent interactions. To introduce thermodynamics of electrochemical processes, kinetics of electrochemical reactions, electrochemistry of fuel cells, batteries and super capacitors.	
Course Outcomes:	Students should be in a position to understand various concepts of electrochemistry. Students should be in a position to apply the knowledge of electrochemistry for their dissertation and research work. Students should be in a position to apply these concepts during the lab course in physical chemistry.	
Content:	3. **Electrolyte Solutions** 1.1 Ion-solvent interactions. Born Theory, validity and limitations. 1.2 Difference between solvation number and coordination number. 1.3 Ion-ion interactions and Debye-Huckel theory of ion cloud. 1.4 Concept of ionic strength and activity coefficient. 1.5 Debye-Huckel limiting law and its modifications. 1.6 Transport of ions in solution. Relaxation and Electrophoretic effects. 1.7 Debye-Huckel-Onsager equation, validity and limitations. **2. Electrified Interfaces** 2.1 Formation of an electrified interface and its structure. 2.2 Polarizable and non-polarizable interfaces. 2.3 Concepts of outer potential, surface potential, inner potential and relationship between them, chemical and electrochemical potentials. 2.4 Concept of surface excess, Electro-capillary curves, Condition for thermodynamic equilibrium at electrified interface. 2.5 Generalized Gibbs equation, Lippmann equation and capacity of the double layer. 2.6 Models of the electrified interface. 2.7 Surface phase and Gibbs adsorption equation. Surface tension and adsorption on solid. Determination of surface excess. **3. Electrode Kinetics and Corrosion** 3.1 Disturbance of electrode equilibrium, cause of electron transfer, fast and slow systems and their current-potential relationship. 3.2 Butler-Volmer equation and its low and high field approximations. 3.3 Nernst equation as a special case of B-V equation. 3.4 Tafel plots for anodic and cathodic processes. 3.5 Study of pH-potential diagrams.	8 hours 8 hours 8 hours

	3.6 Pourbaix diagram for corrosion of iron. **4. Colloids and Mircoemulsions.** 4.1 Charge and Stability of Sols. DLVO theory 4.2 Electrokinetic phenomena: Electroosmosis, streaming potential and current, electrophoresis. Zeta potential. 4.3 Donnan membrane equilibria. 4.4 Micelles and reverse micelles: solubilisation, and bilayers. 4.5 Microemulsions **5. Electrochemical Energies** 5.1 Thermodynamics of electrochemical energy conversion. 5.2 Batteries: basic principles; rating and shelf life. Zinc-manganese dioxide: Leclanche and alkaline batteries. Lithium ion batteries and recharge ability. 5.3 Fuel cells: Principle of a hydrogen-oxygen fuel cell. Classification of fuel cell systems based on types of electrolytes/temperature. Direct methanol-polymer electrolyte fuel cell and electro-catalysts - a case study. Reactions occurring in various fuel cells and calculation of their electrode and cell potentials 5.4 Super capacitors: Introduction: Origin of supercapacitance. Aqueous systems – ruthenium oxide/carbon with sulphuric acid and or solid polymer electrolytes.	6 hours 6 hours
Pedagogy:	Mainly lectures/ tutorials /assignments/ presentations/ self-study or a combination of these could also be used. Sessions shall be interactive in nature to enable peer group learning.	
Text Books/ Reference Books	6. J.O.M. Bockris & A.K.N. Reddy, *Modern Electrochemistry*, Springer India Pvt. Ltd, 2000, Vol. 1, 2 and 3. 7. D.Crow, *Principles and Applications of Electrochemistry*, Blackie Academy and Professional, 1994. 2. C.M.A. Brett & A.M.O. Brett, *Electrochemistry: Principles, methods and applications*, Oxford, New York Oxford University Press, 1993 3. R.D. Vold & M.J. Vold, *Colloid and Interface Chemistry*, Addison-Wesley, 1983. 4. A. Vincent & B. Sacrosati, *Modern Batteries*, John Wiley, New York, 1997. 5. J.O. M. Bockris & S. Srinivasan, *Fuel cells: their Electrochemistry*, McGraw-Hill Book Co., 1969.	