ARSD College, University of Delhi

Model Course Handout/Lesson Plan

Course Name : B.Sc. (Hons) Chemistry						
Semester	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Credit (C)**
III	CHEMISTRY - CVII: PHYSICAL CHEMISTRY –III	Phase Equilibria and Electrochemical Cells	4		0	4
Teacher/Instructor(s)		Dr. Meenakshi Gupta, Mr. Vishnu Kumawat				
Session		2022-23				

Course Description:

The aim of this course is to make students understand phase, co-existence of phases, phase diagram, CST and distribution law and concepts of electrochemical cells, electrode potential, electrochemical series and learn about surface phenomenon, adsorption isotherms, BET Equation.

Course learning outcome: By the end of the course, students will be able to: • Understand phase equilibrium, criteria, CST, Gibbs-Duhem-Margules equation. • Learn the working of electrochemical cells, galvanic cell, corrosion and happenings in surroundings related to electrochemistry.

Lesson Plan:

Unit No.	Learning Objective	Lecture No.	Topics to be covered
1.	Phase Equilibria	1-2	Phase Equilibria: Concept of phases, components and degrees of freedom
		3-4	Derivation of Gibbs Phase Rule for nonreactive and reactive systems
		5-6	Clausius-Clapeyron equation and its applications to solidliquid, liquid-vapour and solid-vapour equilibria
		7-8	Phase diagram for one component systems (H_2O), with applications
		9-10	Phase diagram for one component systems (S), with applications, A comparison between the phase diagram of CO_2 and H_2O
		11-12	Phase diagrams for systems of solid-liquid

			equilibria involving eutectic system
		13-14	Phase diagrams for systems of solid-liquid equilibria involving congruent melting points.
		15-16	Phase diagrams for systems of solid-liquid equilibria involving incongruent melting points.
		17-18	Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal)
		19-20	Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (non-ideal)
		21-22	Introduction of Azeotropes and lever rule
		23-24	Partial miscibility of liquids and CST
		25-26	Nernst distribution law: its derivation and applications.
		27	Last year Question paper discussion and doubt session
2.	Electrochemistry	1- 2	Electrochemical Cells: Rules of oxidation/reduction of ions based on half-cell potentials.
		3-4	Electrochemical Cells: Applications of electrolysis in metallurgy and industry.
		5-6	Electrochemical Cells: Chemical cells, reversible and irreversible cells with example.
		7-8	Electrochemical Cells: Standard electrode (reduction) potential and its application to different kinds of half-cells.
		9-10	Electrochemical Cells: Electromotive force of a cell and its measurement,
		11-12	Electrochemical Cells: Nernst equation; Application of EMF measurements in determining (i) free energy
		13-14	Application of EMF measurements in determining (ii) enthalpy and entropy of a cell reaction,
		15-16	Application of EMF measurements in determining (ii) equilibrium constants.
		17-18	Application of EMF measurements in determining (iii) pH values, using hydrogen, quinone-hydroquinone,
		19-20	Application of EMF measurements in determining: glass and SbO/Sb_2O_3 electrodes.
		21-22	Concentration cells: Concentration cells with and without transference, liquid junction potential.
		23-24	Potentiometric titrations: Qualitative discussion of potentiometric titrations (acid-base)
		25-26	Potentiometric titrations: redox, precipitation
		27	Test
3.	Surface chemistry	1-2	Surface chemistry: Physical adsorption, Chemisorption,

		3-4	Surface chemistry: adsorption isotherms (Langmuir and Freundlich).
		5	Surface chemistry: Nature of adsorbed state
		6	Surface chemistry: Qualitative discussion of BET.

Evaluation Scheme:

No.	Component	Duration	Marks
1.	Internal Assessment		25
	• Quiz		
	• Class Test		
	• Attendance		
	• Assignment		
2.	End Semester Examination	3 hr.	75

Details of the Course		
Unit	**Contents**	**Contact Hours**
I	**Phase Equilibria:**Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solidliquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H_2O and S), with applications. A comparison between the phase diagram of CO_2 and H_2O. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.	27
II	**Electrochemical Cells:** Rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).	27
III	**Surface Chemistry:** Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Qualitative discussion of BET.	6
	Total	**60**

Suggested Books:

Sl. No.	Name of Authors/Books/Publishers	Year of

		Publication/Reprint
1.	Atkins, P.W.; Paula, J.de. Atkin's Physical Chemistry Ed., 10th Edition, Oxford University Press.	2014
2.	Castellan, G. W., Physical Chemistry, 4th Edition, Narosa.	2004
3.	Kapoor, K.L., A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.	2013
4.	Kapoor, K.L., A Textbook of Physical Chemistry, Vol 5, 3rd Edition, McGraw Hill Education.	2015
5.	McQuarrie, D. A.; Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.	2004
Mode of Evaluation:	Internal Assessment / End Semester Exam	