First Semester 2015-2016
Course Handout (Part-II)

Date: 03/08/2015

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 F211
Course Title : Physical Chemistry I
Instructor-in-charge : Subit Kumar Saha
Tutor: Subit Kumar Saha

Course Description:
Kinetic - molecular theory of gases; perfect gas; pressure and temperature; Maxwell distribution; collisions, effusion, mean free path; Boltzmann distribution law and heat capacities; zeroth law and temperature; work, internal energy, heat, and the first law of thermodynamics; Joule-Thomson expansion and enthalpy; second law; heat engines, cycles; entropy; thermodynamic temperature scale; material equilibrium; Gibbs energy; chemical potential; phase equilibrium; reaction equilibrium; standard states, enthalpies; Temperature dependence of reaction heats; third law; estimation of thermodynamic properties; perfect gas reaction equilibrium; temperature dependence; one component phase equilibrium, Clapeyron equation; real gases, critical state, corresponding states; solutions, partial molar quantities, ideal and non-ideal solutions, activity coefficients, Debye-Hückel theory; standard state properties of solution components; Reaction equilibrium in non-ideal solutions, weak acids-buffers, coupled reactions; multi component phase equilibrium- colligative properties, two and three component systems, solubility; electrochemical systems- thermodynamics of electrochemical systems and galvanic cells, standard electrode potentials, concentration cells, liquid junction, ion selective electrodes, double layer, dipole moments and polarizations, applications in biology, concept of overvoltage.

Scope and Objective of the Course:
This is the first of the four Physical Chemistry courses designed for M.Sc. (Hons.) Chemistry Programme. The laws of thermodynamics are discussed, and representative applications in phase equilibrium, reaction equilibrium, and electrochemistry presented.

Text Books:
T1. Levine Ira N., *Physical Chemistry*, 6th ed., Tata McGraw-Hill, New Delhi, 2009.

Reference Books:
R1. Donald A. McQuarrie and John D. Simon, *Molecular Thermodynamics*, Viva Book Pvt. Ltd., New Delhi, 2004.
R2. K. G. Denbigh, *Principles of Chemical Equilibrium*, 4th Ed. Oxford University Press, New Delhi, 1981,
R3. G. N. Lewis and M. T. Randall (Revised by K. S. Pitzer and L. Brewer), *Thermodynamics*, McGraw-Hill, N.Y., 1961.
R4. Peter Atkins and Julio de Paula, *Atkins' Physical Chemistry*, 8th Ed.,Oxford University Press, New Delhi, 2006.

Course Plan :

Topic	Learning Objectives	No of Lect.	Ref. text
Thermodynamic Systems, Zeroth Law	State Variables, equilibrium States, Thermal Equilibrium and Temperature, Equation of State	1	1.2, 1.3, 1.5 to 1.8
First Law	Work, Internal energy, and Heat Transfer, Exact and Inexact differentials, Enthalpy and Heat Capacities	2	2.1 to 2.12
Second Law of Thermodynamics	Natural & Reversible Processes, Heat Engines, Entropy, Thermodynamic Temperature, Spontaneity & Equilibrium in Isolated Systems	3	3.1 to 3.7, 4.3
Free Energy	Spontaneity and Equilibrium in Non-isolated Systems	1	4.1 to 4.4
Thermodynamic Relationships	Calculation of changes in Thermodynamic Properties	2	4.5, 4.6
Third Law	Absolute Entropy, Low Temperatures	1	5.7, 5.11
Partial Molar Properties	Open Systems, Chemical Potential and Material Transfer, Gibbs-Duhem Equation	1	9.1 to 9.4, 4.7
Thermodynamics of Gases	Perfect Gases & Gas Mixtures, Real Gas, Equations of State, Condensation, fugacity	3	2.7, 2.8, 6.1, 8.1 to 8.8,10.10, **R1 2.1 to 2.7**
Reaction Equilibrium	Nature of Chemical Equilibrium, Equilibrium Constant K, Thermochemistry, Temperature dependence of K, Equilibrium Calculations	3	4.8, 6.2 to 6.6, 5.1 to 5.5, 5.8, 5.9, 11.4, 11.5
One-Component Phase Equilibrium	Gibbs Phase Rule, Phase Diagram, Critical Phenomena	3	4.8, 7.1 to 7.5
Solutions of non-electrolytes	Fully ideal, and ideally dilute solutions. Non-ideal solutions: Activity and Activity coefficients, Solid-Liquid and Liquid-Vapor Equilibrium, Reaction Equilibrium	4	9.5 to 9.8, 10.1 to 10.5, 12.1 to 12.11, 11.4, 11.7, 11.8, **R1 10.9**
Electrolyte Solutions	Ionic activities, ionic interactions, Debye-Hückel Theory	2	10.6 to 10.10

Electrochemical Systems	Reversible Electrodes and galvanic Cells, Cell Potential and Reaction Gibbs Energy, Nernst Equation, Applications	2	13.1 to 13.10
Kinetic theory of gases	Kinetic - molecular theory of gases; perfect gas; pressure and temperature; Maxwell distribution; collisions, effusion, mean free path; Boltzmann distribution law and heat capacities;	3	14.1 to 14.10 **R4 21.1-21.4**
Reaction Equilibrium in non-ideal systems	Solubility Product, Weak Acids, Buffers, Coupled Reactions.	3	11.1 to 11.10 **R4 7.1-7.4 (upto p.215)**
Multi component Phase Equilibrium	Colligative Properties; Two and Three component Systems; Solubility	3	12.1 to 12.12
Electrochemical Applications	Ion selective electrodes, Double layer, dipole moments and polarizations, biological applications; Overvoltage as a concept to introduce importance of kinetic measurements.	3	13.11 to 13.15 with some references to Ch.15

Evaluation Scheme:

Components	Duration	Marks	Date & Time	Venue	Remarks
Mid-Sem-Test	1½ hrs	30		9/10 2:00 - 3:30 PM	-
Quiz and Assignments		30	Continuous		@
Comprehensive Examination	3 hrs	40		11/12 FN	Partly OB

@ The tutorial hour will be used for a quick review of the highlights of the material covered in the lectures, clarification of doubts and problem solving, including as part of evaluation. Problem sets will be assigned and quiz will be conducted periodically. Students are expected to be regular in attending classes, and participate in the discussion. The comprehensive examination will include an open book part.

Chamber Consultation Hour: Will be announced later. Students may also meet me at any time mutually convenient.

Makeup Policy: See Part I for details.

Notices: Notices, if any, concerning the course will be displayed on the notice board of Chemistry Department.

Instructor-in-charge
CHEM F211