

**FIRST SEMESTER 2020-2021**

**Course Handout Part II**

Date: 17-08-2020

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

**Scope and Objective of the Course:** This is the first of the four Physical Chemistry courses designed for M.Sc. Chemistry Programme. The laws of thermodynamics are discussed, and representative applications in phase equilibrium, reaction equilibrium, and electrochemistry presented. Reaction equilibria in the systems with ideal gases and non-ideal gases, and thermodynamics of fully ideal, ideally dilute and non-ideal solutions described.

**Textbooks:**

1. 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.

**Course Plan:**

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| **Lecture No.** | **Learning objectives** | **Topics to be covered** | **Chapter in the Text Book** |
| 1-2 | State Variables, equilibrium States, Thermal Equilibrium and Temperature, Equation of State | Thermodynamic Systems, Zeroth Law | 1.2, 1.3, 1.5 (Self- study), 1.6, 1.7 |
| 3-4 | Work, Internal energy, and Heat Transfer, Exact and Inexact differentials, Enthalpy and Heat Capacities | First Law | 2.2 to 2.11 |
| 5-7 | Natural & Reversible Processes,  Heat Engines, Entropy, Thermodynamic Temperature, Spontaneity & Equilibrium in Isolated Systems | Second Law of Thermodynamics | 3.1 to 3.7 |
| 8-9 | Spontaneity and Equilibrium in Non-isolated Systems | Free Energy | 4.1 to 4.4 |
| 10-11 | Calculation of changes in Thermodynamic Properties | Thermodynamic Relationships | 4.5, 4.6 |
| 12 | Absolute Entropy, Low Temperatures | Third Law | 5.7, 5.11 |
| 13-14 | Open Systems, Chemical Potential and Material Transfer, Gibbs-Duhem Equation | Partial Molar Properties | 9.1 to 9.4, 4.7 |
| 15-17 | Perfect Gases & Gas Mixtures, Real Gas, Equations of State, Condensation, fugacity | Thermodynamics of Gases | 2.7, 2.8, 6.1, 8.1 to 8.8, 10.10 |
| 18-20 | Nature of Chemical Equilibrium, Equilibrium Constant K, Thermochemistry, Temperature dependence of K, Equilibrium Calculations | Reaction Equilibrium | 4.8, 6.2 to 6.4, 6.6, 5.1 to 5.5, 5.8, 5.9, 11.4, 11.5 |
| 21-23 | Gibbs Phase Rule, Phase Diagram, Critical Phenomena | One-Component Phase Equilibrium | 4.7, 7.1 to 7.4 |
| 24-27 | Fully ideal, and ideally dilute solutions. Non-ideal solutions: Activity and Activity coefficients, Solid-Liquid and Liquid-Vapor Equilibrium, Reaction Equilibrium | Solutions of non-electrolytes | 9.5 to 9.8, 10.1 to 10.4, 12.1 to 12.4, 11.4, 11.7 |
| 28-29 | Ionic activities, ionic interactions, Debye-Hückel Theory | Electrolyte Solutions | 10.5-10.7, 10.10 |
| 30-31 | Reversible Electrodes and galvanic Cells, Cell Potential and Reaction Gibbs Energy, Nernst Equation, Applications | Electrochemical Systems | 13.4 to 13.10 |
| 32-33 | Kinetic - molecular theory of gases; perfect gas; pressure and temperature; Maxwell distribution; collisions, effusion, mean free path; Boltzmann distribution law and heat capacities; | Kinetic theory of gases | 14.1 to 14.5, 14.6-14.7(Self-study), 14.9,14.10 |
| 34-36 | Solubility Product, Weak Acids, Buffers, Coupled Reactions. | Reaction Equilibrium in non-ideal systems | 11.1, 11.2-11.3(Self-study), 11.4,11.5 |
| 37-39 | Colligative Properties; Two and Three component Systems; Solubility | Multi component Phase Equilibrium | 12.5 to 12.8 |
| 40-42 | Ion selective electrodes, Double layer, dipole moments and polarizations, biological applications; Overvoltage as a concept to introduce importance of kinetic measurements. | Electrochemical Applications | 13.11 to 13.15 with some references to Ch.15 |

**Evaluation Scheme:**

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| **Component** | **Duration**  **(Minutes)** | **Weightage (%)** | **Date & Time** | **Nature of Component** |
| Test I | 30 | 15 | September 10 –September 20 (During scheduled class hour) | Open Book |
| Test II | 30 | 15 | October 09 –October 20 (During scheduled class hour) | Open Book |
| Test III | 30 | 15 | November 10 – November 20 (During scheduled class hour) | Open Book |
| Quiz/Assignment/  Viva# | - | 20 | Continuous | Open Book |
| Comprehensive Examination | 120 | 35 | TBA | Open Book |

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, and conducting any evaluation component. Quiz/assigned/viva will be conducted periodically. Students are expected to be

regular in attending classes, and participate in the discussion.

**Chamber Consultation Hour:** Every Tuesday except holiday between 5:00 PM to 6:00 PM.

**Notices:** All notices would be displayed in CMS.

**Make-up Policy:** See Part I for details.

**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.

**INSTRUCTOR-IN-CHARGE**

CHEM F211