CHE409 PHYSICAL CHEMISTRY Credits: 4

COURSE OUTCOMES

CO1: Explain fundamental concepts in statistical mechanics, including microscopic states, ensembles, and partition functions, and their role in describing thermodynamic systems.

CO2: Apply statistical mechanics to evaluate thermodynamic properties such as internal energy, entropy, and free energy, connecting microscopic behaviour to macroscopic observables.

CO3: Understand nuclear properties, models, and phenomena, including radioactive decay, nuclear reactions, and their implications in chemistry and energy generation.

CO4: Analyze experimental techniques for determining dissociation constants of acids and study the properties of solutions, with a focus on electrolyte behaviour and ionic equilibria.

CO5: Correlate theoretical principles of statistical mechanics and nuclear chemistry with experimental data to enhance problem-solving skills in physical chemistry.

CO6: Demonstrate proficiency in applying concepts of statistical and nuclear chemistry to real-world scenarios, including reaction kinetics and thermodynamic stability.

Unit: 1 Statical Thermodynamics

- Introduction, Aspects of statistics, Definition of microscopic states, Statistical weight, Macroscopic states, Most probable distribution system, Assembly.
- Assembly of localized and non-localized systems, Ensemble, Micro-canonical ensemble, Macro canonical ensemble and grand canonical ensemble.
- Boltzmann and Planck equation, Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein Statistics, Partition function and its significance, Translational, Rotational Vibrational and Electronic partition functions, and their evaluation.
- Thermodynamic properties in terms of partition functions, Internal energy
- Molar heat capacity, Entropy, and free energy functions, Translational, rotation and vibrational entropies of ideal mono atomic gases, Sackur-Tetrode equation.
- Statistical expression for equilibrium constant for metathetic reactions
- Numericals

Unit 2 Nuclear Chemistry

- Nuclear properties-nuclear radius, coulombic and nuclear potential radius, nuclear spin and angular momentum, magnetic moment, nuclear binding energy.
- Nuclear models-shell model, liquid drop model, Fermi gas model, collective model.
- Radioactive decay, nuclear reactions, evaporation, spallation, fragmentation, fission and fusion reactions, accelerators, reaction cross section, Use of radioisotopes as tracers

Unit 3 Electro Chemistry

- Determination of dissociation constant of monobasic acids by conductometry.
- Determination of dissociation constants of monobasic and polybasic acids by potentiometry.
- The electrical double layer, the rate of charge transfer, Determination of activities of solutes from activities of solvent.
- Dependence of electrolyte activity on hydration number, Bjerrum's theory of ion association in electrolyte solutions, Determination of interfacial tension of mercury as a function of potential across the interface.

Unit 4 Properties of Solutions

- Ideal solutions & its properties, The Duhem-Margules equation, Application of Raoult's law to both constituents of an ideal solution.
- Vapour Pressure curves for an Ideal solution, Composition of liquid & vapour in equilibrium.
- Non-idea solutions & its vapour pressure curves, Dilute solutions, Henry's Law.
- Solutions of electrolytes: Mean ionic activity, Mean ionic activity coefficient & mean ionic molality of the electrolyte.
- Listing of the methods determining mean ionic activities, Ionic strength principle, Numericals.

Reference Books

1. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli, ArunBahl,S. Chand & Company Ltd.
2. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma and Madan S. Pathania, Visual Publishing Co.
3. Physical chemistry by W.J.Moore, 5th edition, orient Longman private ltd.
4. Textbook of physical chemistry by S. Glasstone, D. Van Nostrand company, inc., 1946.
5. Advanced physical chemistry by Gurdeep Raj.