BACHELORS WITH NANOTECHNOLOGY AS MAJOR (CT – I) 2nd SEMESTER

NTY223J: NANOTECHNOLOGY _ ESSENTIALS OF CHEMISTRY IN NANOTECHNOLOGY COURSE OBJECTIVES COURSE OUTCOME This course places emphasis on imparting the essential concepts and principles of Chemistry necessary for comprehending various important and essential aspects of Nanoscience and Nanotechnology. Successful completion of this course will enable the students to understand the underlying principles of Nanoscience and Nanotechnology. • This course will also act as the stepping stone for grasping the more advanced concepts encountered towards the end of this programme.

UNIT I

(15 LECTURES)

Atomic Structure: Wave Mechanical concept of Atomic Structure: de-Broglie's wave equation; derivation and experimental verification. Heisenberg's Uncertainty Principle: Illustration and significance. Confirmation of quantization of angular momentum and its significance. Wavefunction and its significance, radial and angular wave functions for hydrogen atom. Radial and angular distribution curves; Shapes of s, p & d orbitals; Effective nuclear charge and its calculation by Slater rules.

Periodic Properties: Trends in Atomic, Ionic, Metallic and Van der Waal radii. Successive ionization energies and factors affecting ionization energy. Electronegativity and Electron Affinity: Trends, Methods of determination; Applications in predicting and explaining the chemical behaviour of elements.

UNIT II

(15 LECTURES)

Chemical Bonding: Ionic Bond: Lattice energy and Born Haber Cycle. Factors affecting the structure of ionic solids; Radius ratio effect; Coordination number and limitations of radius ratio rule. Fajan's rules and its applications.

Solvation energy and solubility of ionic solids. Factors affecting the solubility of ionic solids. Metallic bond: Characteristics, comparison with ionic and covalent bonds. Types of intermolecular forces: Hydrogen bonding, Dipole-dipole forces, London forces and ion-dipole forces. Significance of such forces.

Valence bond theory: Directional characteristics of covalent bond and types of hybridizations. Limitations of VB theory. Percent ionic character from dipole moment and electronegativity difference.

VSEPR theory: Assumptions; Shapes of some molecules (BF3, NH3, H2O, SF4, ClF3 and XeF2)

Molecular Orbital Theory: Energy level diagrams, Bond order with its significance and application to simple molecules (N2, O2, HCl and CO).

UNIT III

(15 LECTURES)

Basic Concepts in Organic Chemistry: Inductive and Electromeric effects. Conjugation, Resonance and Hyperconjugation. Reactive intermediates: Structure, generation and stability of Carbocations, Carbanions, Free radicals, Carbenes, Benzynes and Nitrenes.

Concept and types of stereoisomerism. Geometrical Isomerism: Configuration of geometrical isomers. E and Z system of nomenclature. Optical Isomerism: Elements of symmetry, molecular chirality, chiral and achiral molecules with two stereogenic centers. Enantiomers, diastereoisomers and Meso compounds. Resolution of enantiomers. Inversion, retention and racemization. Relative and absolute configurations. D, L and R, S systems of nomenclature.

UNIT IV

(15 LECTURES)

Essential Concepts in Physical Chemistry: Order of reaction; derivation of rate equations for second and third order reactions (one reactant only). Determination of order of reaction by differential rate, integration, half-life period and isolation methods. Temperature dependence of reaction rates: Arrhenius equation, concept of activation energy.

Thermodynamic functions: State and path functions and their differentials. Thermodynamic processes. Concept of heat and work. Heat capacities at constant volume and constant pressure and their relationship. Joule's law, Joule-Thomson coefficient and inversion temperature.

Equilibrium: Concept of Free energy, Equilibrium constant and free energy change. Reaction isotherm and reaction isochore, Clapeyron equation and Clausius-Clapeyron equation, applications. Phase rule: Meaning of the terms: phase, component and degree of freedom, statement of Gibbs phase rule, phase diagrams of one component system – water.

Electrochemistry: Arrhenius theory of electrolyte dissociation and its limitations. Migration of ions and Kohlrausch's law, Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment).

PRACTICALS (2 CREDITS: 60 HOURS)

- > Preparation of solutions of different concentrations; Standardization of solutions (acids and bases).
- ➢ Volumetric estimation of oxalic acid by titrating it with KMnO₄.
- > Determination of ferrous ions by dichromate method using titrimetric method.
- > Purification of organic compounds by crystallization (from water and alcohol) and sublimation.
- Detection of N, S and halogens in organic compounds.
- > Measurement of density and relative density of various liquids using pycnometer / density bottle.
- > Determination of heat capacity of calorimeter for different volumes.
- > Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide

BOOKS (PRESCRIBED / RECOMMENDED):

- Basic Inorganic Chemistry; F.A. Cotton, G Wilkinson & P.L. Gauss; 3rd ed.; Wiley; 2002.
- Concise Inorganic Chemistry; J.D. Lee; 5th ed.; ELBS; 2003
- Inorganic Chemistry; D.E. Shriver; P.W. Atkins & C.H. Langford; 4th ed.; Oxford; 2006
- Principles of Physical Chemistry; Puri, Sharma and Pathania; S. Nagin Chand & Co; 2011
- Physical Chemistry; A Molecular Approach, McQuarie, Viva Pvt. Ltd., 2021
- The Elements of Physical Chemistry; P. W. Atkins; 7th ed., Oxford University Press; 2016
- Organic chemistry (8th Ed); Bruice, Paula Yurkanis, Pearson Prentice Hall, 2007
- Organic Chemistry by John E McMurry (8th Edition) Pearson Education, 2011
- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Comprehensive Practical Organic Chemistry: Qualitative analysis Ahluwalia, V.K. & Sunita Dhingra; Universities Press, India, 2004.
- Advanced Practical Organic Chemistry; N. K. Vishnoi; 3rdEdn; Vikas Publishing, 2009.
- Advanced Practical Physical Chemistry; J.B. Yadav; Krishna Prakashan Media (P) Limited, 2015.