Course name: Chemistry – I (Preparatory, 1st semester)

Course Type	Course Code	Name of the Course	L	T	P	Credit
IC	NCYP001	Chemistry-I	3	1	0	4

Course Objective

Preparatory students should develop a basic conceptual understanding of chemical reactions and their kinetics, and thermodynamics, which will be useful for most engineering branches. They also need to develop an understanding of the relationship between the structure and function of organic and inorganic materials they may work with in the future. This preparatory course will help them to prepare for the advanced Chemistry courses that they have to take up during their first year of B Tech course.

Learning Outcomes

- Understanding the physical principles that govern the properties of atoms and molecules.
- Knowledge of different states of matter and their properties.
- Understanding of chemical reactions and their thermodynamics that is the backbone of physical chemistry.
- Develop an understanding of the structure and property relationship of aliphatic and aromatic compounds.
- Understand basic organic reactions and their mechanisms.
- Understand the basic nature of chemical bonding in inorganic compounds.
- Knowledge of transition metal elements and their compounds.

Unit No.	Topics to be Covered	Lecture Hours (L + T)	Learning Outcome
1	**Module 1: General topics** Concept of atoms and molecules; Dalton's atomic theory; Mole concept; Chemical formulae; Balanced chemical equations; Calculations (based on mole concept) involving common oxidation-reduction, neutralization, and displacement reactions; Concentration in terms of mole fraction, molarity, molality and normality.	3L + 1T	Fundamental concepts of chemical reactions.
	Module 2: Gaseous and liquid states Absolute scale of temperature, Ideal gas equation; Deviation from ideality, Van der Waals equation; Kinetic theory of gases, average, root mean square and most probable velocities and their relationship with temperature; Law of partial pressures; Vapor pressure; Diffusion of gases.	4L +2T	Different states of matter and atomic/molecular interactions in these states.
	Module 3: Solutions Raoult's law; Molecular weight determination from lowering of vapor pressure, elevation of boiling point and depression of freezing point.	2L + 1T	Different properties of solute and solvents that controls the properties of a solution.

	Module 4: Energetics First law of thermodynamics; Internal energy, work and heat, pressure-volume work; Enthalpy, Hess's law; Heat of reaction, fusion and vaporization; Second law of thermodynamics; Entropy; Free energy; Criterion of spontaneity.	3L +1T	Fundamental concepts of thermodynamics that control different chemical processes.
	Module 5: Chemical equilibrium Law of mass action; Equilibrium constant, Le Chatelier's principle (effect of concentration, temperature, and pressure); Significance of DG and DG^{o} in chemical equilibrium; Solubility product, common ion effect, pH and buffer solutions; Acids and bases (Bronsted and Lewis concepts); Hydrolysis of salts.	2L + 1T	Basic understanding of chemical equilibrium and factors that affect them.
2	**Module 1: Basics concepts of organic chemistry** IUPAC nomenclature of simple organic compounds (only hydrocarbons, mono-functional and bi-functional compounds); Hybridization of carbon; Sigma and pi-bonds; Shapes of simple organic molecules; Structural and geometrical isomerism; Optical isomerism of compounds containing up to two asymmetric centers, (R,S and E,Z nomenclature excluded); Conformations of ethane and butane (Newman projections); Resonance and hyperconjugation; Keto-enol tautomerism; Determination of empirical and molecular formulae of simple compounds (only combustion method); Hydrogen bonds: definition and their effects on physical properties of alcohols and carboxylic acids; Inductive and resonance effects on acidity and basicity of organic acids and bases; Polarity and inductive effects in alkyl halides; Reactive intermediates produced during homolytic and heterolytic bond cleavage; Formation, structure and stability of carbocations, carbanions and free radicals.	5L + 2T	Fundamental concepts of organic chemistry that describes the properties of organic molecules. Different electronic effects that control the structure and function of organic molecules. Conformation and configuration or organic molecules.
	Module 2: Preparation, properties and reactions of alkanes Physical and chemical properties of alkanes; Homologous series, Preparation of alkanes.	2L	Structure function relationship of alkanes and their chemical synthesis.
	Module 3: Preparation, properties and reactions of alkenes and alkynes Physical and chemical properties of alkenes and alkynes; Acidity of alkynes; Acid catalyzed hydration of alkenes and alkynes; Reactions of alkenes with $KMnO_4$ and ozone; Reduction of alkenes and alkynes; Electrophilic addition reactions of alkenes with X_2, HX, HOX and H_2O (X=halogen); Addition reactions of alkynes; Metal acetylides.	4L + 1T	Synthesis and structure function relationship of alkenes and alkynes. C

	Module 4: Structure and aromaticity of benzene Halogenation, nitration, sulphonation, Friedel-Crafts alkylation and acylation; Effect of o-, m- and p-directing groups in monosubstituted benzenes. substitution reactions.	3L +1T	Provides a brief idea about aromatic/anti-aromatic/non-aromatic compounds. Different substitution reactions of aromatic compounds.
3	**Module 1: Atomic structure and chemical bonding** Bohr model, spectrum of hydrogen atom, quantum numbers; Wave-particle duality, de Broglie hypothesis; Uncertainty principle; Qualitative quantum mechanical picture of hydrogen atom, shapes of s, p and d orbitals; Electronic configurations of elements (up to atomic number 36); Aufbau principle; Pauli's exclusion principle and Hund's rule; Orbital overlap and covalent bond; Hybridization involving s, p and d orbitals only; Orbital energy diagrams for homonuclear diatomic species; Hydrogen bond; Polarity in molecules, dipole moment (qualitative aspects only); VSEPR model and shapes of molecules (linear, angular, triangular, square planar, pyramidal, square pyramidal, trigonal bipyramidal, tetrahedral and octahedral).	6L + 2T	Very basic concept of quantum mechanics. Idea of orbitals. Electronic configuration of atoms and molecules. Structure function relationship of inorganic compounds.
	Module 2: Isolation/preparation and properties of the following non-metals Boron, silicon, nitrogen, phosphorus, oxygen, sulphur and halogens; Properties of allotropes of carbon (only diamond and graphite), phosphorus and sulphur.	3L + 1T	Synthesis and properties of certain non-metals.
	Module 3:Transition elements (3d series) Definition, general characteristics, oxidation states and their stabilities, color (excluding the details of electronic transitions) and calculation of spin-only magnetic moment; Coordination compounds: nomenclature of mononuclear coordination compounds, cis-trans, and ionization isomerism, hybridization and geometries of mononuclear coordination compounds (linear, tetrahedral, square planar and octahedral).	5L +1T	Basic concepts of transition metal elements and their compounds. Structure-function relationship of transition metal compounds.

Text Books:

- Shriver Atkin's Inorganic Chemistry by P. Atkins, T. Overton, J. Rourke, M. Weller, M. Armstrong, 5th Edn, Oxford University Press, 2009
- A Textbook of Engineering Chemistry by Shashi Chawla, Dhanpat Rai & Co.
- Inorganic Chemistry by C.E. House croft, A.G.Sharpe,4thEdn, Pearson Education,2017
- Introduction to Spectroscopy by PAVIA, LAMPMAN, KRIZ, VYAN, Cengage Learning India Private Limited; 5th edition.

- Advanced Physical Chemistry by B.R.Puri, L.R.Sharma & M.S.Pathani, Milestone Publisher.
- Organic Chemistry, J. CLayden, N. Greeves, S.Warren, P. Wother, Oxford University Press, 2000.

Reference Books:

- Atkins' Physical Chemistry, P. Atkins and J.de Paula, 8th edition, Oxford University Press, 2006.
- Principles of polymerization, George G. Odian, 4th Edn, John Wiley &Sons Inc., Publication,2004.