Chemistry-I: Atomic Structure, Chemical Bonding, and Basic Organic Chemistry

1. **Faculty:** Faculty of Chemical Sciences
2. **Course Code:** CHE101
3. **Course Title:** Atomic Structure, Chemical Bonding, and Basic Organic Chemistry
4. **Number of Credits:** 2+0+1

5. **Course objectives:**
6. The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic, covalent, and metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. It discusses the periodicity in properties with reference to the s and p blocks, which is necessary in understanding their group chemistry. The course is also infused with the recapitulation of the fundamentals of organic chemistry that explains the behavior and reaction of carbon compounds. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

7. **Minimum prerequisites for taking this course, if any:**

8. **Course structure with units, if applicable:**

Unit 1: Atomic Structure: Recapitulation of the concept of the atom in ancient India, Bohr's theory & its limitations, atomic spectrum of the hydrogen atom, de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Quantum numbers and their significance. Shapes of s, p, and d orbitals, Relative energies of orbitals. Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle, and its limitations. (Lectures: 7)

Unit 2: Periodic Properties of Elements: Brief discussion of the following properties of the elements, with reference to s- & p-block and their trends: (a) Effective nuclear charge, shielding or screening effect and Slater's rules (b) Atomic and ionic radii (c) Ionization enthalpy (Successive ionization enthalpies) (d) Electron gain enthalpy (e) Electronegativity, Pauling's scale of electronegativity.
(Lectures: 4)

Unit 3: Ionic Bonding: Characteristics of ionic compounds. Lattice energy, Born-Landé equation. Born-Haber cycle and its applications. Covalent character in ionic compounds, polarizing power, and polarizability. Fajan's rules and consequences of polarization.
(Lectures: 5)

Unit 4: Covalent and Coordinate bonds: Covalent Bond-Energy changes, potential energy curve for H_2 molecule, hybridization and resonance. Valence shell electron pair repulsion theory (VSEPR)- Discussion of structures of H_2O, NH_3, SF_4, ClF_3, PCl_5 etc. Molecular orbital theory, Linear combination of atomic orbitals (LCAO) method, structures of simple homonuclear diatomic molecules like H_2, N_2, O_2, F_2. Characteristics of covalent compounds, secondary bonding. Coordinate bond-Werner's theory, effective atomic number (EAN), stability of complexes, isomerism in coordinate compounds.
(Lectures: 9)

Unit 5: Fundamentals of Organic Chemistry: Electronic displacements and their applications: Inductive effect, electromeric effect, resonance, mesomeric effects. hyperconjugation. Concept of dipole moment, acidity, basicity, and pKa values. Cleavage of bonds: homolysis and heterolysis. Reaction intermediates: carbocations, carbanions, and free radicals. Electrophiles and nucleophiles.
(Lectures: 05)

Lab Tech:
Titrimetric Analysis:
(i) Calibration and use of apparatus.
(ii) Preparation of solutions of titrants of different Molarity/Normality.
2. Acid-Base Titrations: Principles of acid-base titrations, and theory of indicators to be discussed.
(i) Estimation of sodium carbonate using standardized HCl.
(ii) Estimation of carbonate and hydroxide present together in a mixture.
(iii) Estimation of carbonate and bicarbonate present together in a mixture.
(iv) Estimation of free alkali present in different soaps/detergents.
3. Oxidation-Reduction Titration: Principles of oxidation-reduction titrations (electrode potentials) to be discussed.
(i) Estimation of Fe (II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe (II) with $K_2Cr_2O_7$ using an internal indicator (diphenylamine, N-phenyl anthranilic acid) and discussion of the external indicator.
4. Calibration of thermometer and determination of melting point.

9. **Reading suggestions:**

- Lee., J. D. A new Concise Inorganic Chemistry, Pearson Education.
- Huheey, J.E.; Keiter, E.; Keiter, R. (2009), Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
- Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M. T.; Armstrong, F.A. (2010), Shriver and Atkin's Inorganic Chemistry, Oxford
- Sykes, P. (2005), A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- Eliel, E. L. (2000), Stereochemistry of Carbon Compounds, Tata McGraw Hill.
- Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Bahl, A.; Bahl, B. S. (2012), Advanced Organic Chemistry, S. Chand.
- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989)
- Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons
- Mann, F.G.; Saunders, B.C. (2009), Practical Organic Chemistry, Pearson Education

10. **Evaluation:**

Theory:	Mid-semester Written Examination	: 40% Marks
	End-semester Written Examination	: 40% Marks
	Quiz / Assignment/Presentation (oral / poster)/other	: 20% Marks