DEPARTMENT OF CHEMISTRY

BSc. (Hons.) Chemistry

Category-I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1): Atomic Structure & Chemical Bonding

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Atomic Structure & Chemical Bonding (DSC-1: Inorganic Chemistry -I)	**04**	**03**	—	**01**	Physics, Chemistry, Mathematics	--

Learning Objectives

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 and covalent bonding, and explains that chemical bonding is best regarded as a continuum between the two cases. It discusses the periodicity in properties with reference to the s and p block, which is necessary in understanding their group chemistry. The student will also learn about the fundamentals of acid-base and redox titrimetric analysis.

Learning outcomes

By the end of the course, the students will be able to:

- Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization enthalpy and electron affinity of elements.
- Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand the concept of lattice energy using Born-Landé and Kapustinskii equation.
- Calibrate the apparatus used in titrimetric analysis and prepare standard solutions for titration
- Understand the theory and application of various acid-base and redox titrations.
- Comprehend the theory of acid-base indicators

SYLLABUS OF DSC-1

UNIT – I (15 Hours)
Unit 1: Atomic Structure

Recapitulation of concept of atom in ancient India, Bohr's theory & its limitations, atomic spectrum of hydrogen atom.

de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Postulates of wave mechanics, Time independent Schrödinger's wave equation, well behaved wave function, significance of ψ and ψ^2. Quantum mechanical treatment of H- atom, Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial function plots, radial probability distribution plots, angular distribution curves. Shapes of *s*, *p*, and *d o*rbitals, Relative energies of orbitals.

Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations.

UNIT – II (6 Hours)

Unit 2: Periodic properties of Elements & Periodic Trends

Brief discussion of the following properties of the elements, with reference to *s*- & *p*-block andtheir 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. Variation of electronegativity with bond order and hybridization.

UNIT – III (12 Hours)

Unit 3: Ionic bond

General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Lattice energy, Born-Landé equation with derivation, Madelung constant, importance of Kapustinskii equation for lattice energy. Born-Haber cycle and its applications.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

UNIT – IV (12 Hours)
Unit 4: Covalent bond
Valence shell electron pair repulsion (VSEPR) theory, shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5,

SF_6, ClF_3, I_3, BrF_2^+, PCl_6^-, ICl_2^- ICl_4^-, and SO_4^{2-}. Application of VSEPR theory in predicting trends in bond lengths and bond angles.

Valence Bond theory (*Heitler-London* approach). Hybridization, equivalent and non-equivalent hybrid orbitals, Bent's rule.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Molecular orbital diagrams of homo & hetero diatomic molecules [N_2, O_2, C_2, B_2, F_2, CO, NO] and their ions; HCl (idea of s-p mixing and orbital interaction to be given).

Practical component
Practicals: Inorganic Chemistry-I **(30 Hours)**

(Laboratory periods: 15 classes of 2 hours each)

1. **Titrimetric Analysis:**
   (i) Calibration and use of apparatus
   (ii) Preparation of solutions ofdifferent Molarity/Normality.

2. **Acid-Base Titrations:** Principles of acid-base titrations to be discussed.
(i) Estimation of oxalic acid using standardized NaOH solution
(ii) Estimation of sodium carbonate using standardized HCl.
(iii) Estimation of carbonate and hydroxide present together in a mixture.
(iv) Estimation of carbonate and bicarbonate present together in a mixture.

3. **Redox Titration:** Principles of oxidation-reduction titrations to be discussed.
(i) Estimation of oxalic acid using standardized $KMnO_4$ solution
(ii) Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
(iii) Estimation of oxalic acid and sodium oxalate in a given mixture.

Essential/recommended readings
References:
Theory :

1. Lee, J.D. (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Pfennig, B. W. (2015), **Principles of Inorganic Chemistry.** John Wiley & Sons.
6. Housecraft, C. E.; Sharpe, A. G., (2018), Inorganic Chemistry, 5th Edition, Pearson.
7. Wulfsberg, G (2002), **Inorganic Chemistry,** Viva Books Private Limited.
8. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

9. Shiver, D.; Weller, M.; Overton, T.; Rourke, J.; Armstrong, F. (2014), **Inorganic Chemistry**, 6th Edition, Freeman & Company
10. Das, A. K.; Das, M. (2014), **Fundamental Concepts of Inorganic Chemistry**, 1st Edition, Volume CBS Publishers & Distributors Pvt. Ltd.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of **Quantitative Chemical Analysis,** John Wiley and Sons.
2. Harris, D. C.; Lucy,C. A.(2016), **Quantitative Chemical Analysis,** 9th Edition, Freeman andCompany

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): Basic Concepts and Aliphatic Hydrocarbons

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts and Aliphatic Hydrocarbons (DSC-2: Organic Chemistry-I)	**04**	**03**	**--**	**01**	Physics, Chemistry, Mathematics	**--**

Learning Objectives

The core course Organic Chemistry I is designed in a manner that it forms a cardinal part of the learning of organic chemistry for the subsequent semesters. The course is infused with the recapitulation of fundamental concepts of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts, the functional groups-alkanes, alkenes, alkynes are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Learning outcomes

On completion of the course, the student will be able to:

- Understand and explain the electronic displacements and reactive intermediates and their applications in basic concepts.
- Formulate the mechanistic route of organic reactions by recalling and correlating the fundamental concepts.