Teaching Plan-2024

Course: B.Sc. Chemistry (H) NEP, Ist Semester
Paper: DSC-1, Atomic Structure and Chemical Bonding
UPC: 2172011101
Teacher: Dr. Reeta Sharma

Week	Date from - to	Topic
I	29/08/2024 - 07/09/2024	Discussion of syllabus and related books **Unit-2: Periodic Properties of Elements & Periodic Trends** Brief discussion of the following properties of the elements, with reference to *s*- & *p*-block and their trends: Effective nuclear charge, shielding or screening effect and Slater's rules, Atomic and ionic radii.
II	09/09/2024 - 14/09/2024	Ionization enthalpy (Successive ionization enthalpies), Electron gain enthalpy, Electronegativity, Pauling's scale of electronegativity. Variation of electronegativity with bond order and hybridization. **Assignment -I**
III	16/09/2024 - 21/09/2024	**Unit-3: Ionic bond** General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals.
IV	23/09/2024 - 28/09/2024	Lattice energy, Born-Landé equation with derivation, Madelung constant, importance of Kapustinskii equation for lattice energy. Born-Haber cycle and its applications
V	30/09/2024 - 05/10/2024	Covalent character in ionic compounds, polarizing power and polarizability Fajan's rules and consequences of polarization. **Test-I**
VI	07/10/2024 - 12/10/2024	**Unit 4: Covalent bond** General characteristics of covalent bonding. Valence Bond theory (*Heitler-London* approach). Hybridization, equivalent and non- equivalent hybrid orbitals, Bent's rule, type of Hybridization discussion of SP, SP2, SP3 Hybridization.
VII	14/10/2024 - 19/10/2024	Type of Hybridization SP3d, SP3d2, dsp2 and dsp3, Valence shell electron pair repulsion (VSEPR) theory, shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H2O, NH3,
VIII	21/10/2024 - 26/10/2024	PCl3, PCl5, SF6, ClF3, I3, BrF2+, PCl6-, ICl2- ICl4-, and SO42-. Application of VSEPR theory in predicting trends in bond lengths and bond angles. **Assignment -II**
IX	28/10/2024 - 02/11/2024	---------- **Mid Semester Break**----------

X	04/11/2024 - 09/11/2024	Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. Molecular Orbital Theory.
XI	11/11/2024 - 16/11/2024	Molecular orbital diagrams of homonuclear diatomic molecules of N2, O2, C2, B2, F2,
XII	18/11/2024 - 23/11/2024	Molecular orbital diagrams of heteronuclear diatomic molecules such as CO, NO and their ions; HCl (idea of s-p mixing and orbital interaction to be given). **Test-II**
XIII	25/11/2024 - 30/11/2024	**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,
XIV	02/12/2024 - 07/12/2024	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.
XV	09/12/2024 - 14/12/2024	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
XVI	16/12/2024 - 24/12/2024	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. **Remedial Class**

(Dr. Reeta Sharma)
Associate Professor

Syllabus for Undergraduate Programme in Chemistry

DISCIPLINE SPECIFIC CORE (DSC) COURSES

SEMESTER I

Course Code: DSC 1: INORGANIC CHEMISTRY – I

Course Title: Atomic Structure & Chemical Bonding

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Lectures: Theory- 45, Practical- 15 classes of 2 hours each

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

Unit 1: **Lectures: 14**

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, Quantumnumbers 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* orbitals, Relative energies of orbitals.

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

Unit 2: Periodic properties of Elements & Periodic Trends **Lectures: 6**

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. Variation of electronegativity with bond order and hybridization.

Unit 3: Ionic bond **Lectures: 12**

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 4: Covalent bond **Lectures: 13**

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).

Practicals: Inorganic Chemistry-I **Credits: 01**

(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.

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 and Company

Teaching Learning Process:

- Conventional chalk and board teaching,

- Class interactions and discussions
- Power point presentation on important topics

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- Continuous evaluation during laboratory classes.
- Mock Practical
- Viva-voce
- End semester University Theory/ Practical Examination

Keywords: Atomic Structure, Wave function, Quantum Numbers, Electronegativity, Ionic Bonding, Dipole Moment, VSEPR Theory, Covalent Bonding, Multiple Bonding, Molecular Orbitals, Bonding MO, Antibonding MO, Homonuclear, Heteronuclear, Titrimetric Analysis, Acid-Base Titrations, Redox Titrations, Acid-Base Indicators