ARSD College, University of Delhi

Model Course Handout/Lesson Plan

Course Name : B.Sc. (P) APSIC						
Semester	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Credit (C)**
I	42171103 CC-CI: Core Course CHEMISTRY 1	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	**4**			**4**
Teacher/Instructor(s)		Dr. Neha Bhardwaj				
Session		2020-2021				

Course Objective: 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 block, which is necessary in understanding their group chemistry. The course is also infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a threedimensional space. To establish the applications of these concepts, the classes of alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Course Learning Outcomes: By the end of this course, 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 energy 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 and explain the differential behavior of organic compounds based on fundamental concepts learnt.
• Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
• Learn and identify many organic reaction mechanisms including free radical substitution, electrophilic addition and electrophilic aromatic substitution.

Lesson Plan:

Unit No.	Learning Objective	Lecture No.	Topics to be covered
1.	Atomic Structure	1-2	Review of: Bohr's theory and its limitations, Heisenberg uncertainty principle, Dual behaviour of matter and radiation, De-Broglie's relation,
		3-4	Hydrogen atom spectra, need of a new approach to atomic structure. What is Quantum mechanics?
		5-6	Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2 , Schrödinger equation for hydrogen atom, radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation)
		7-8	radial and angular nodes and their significance, radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals.
		9-10	Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes, discovery of spin,
		11-12	spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and completely filled orbitals
		13-14	concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.
	Chemical Bonding and Molecular Structure	15-16	Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds
		17-18	statement of Born-Landé equation for calculation of lattice energy (no derivation), BornHaber cycle and its applications, covalent character in ionic compounds,
		19-20	polarizing power and polarizability, Fajan's rules. Ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.
		21-22	Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H2O, NH3, PCl5, SF6, ClF3, SF4)

2		23-24	hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.
		25-26	Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs
		27-28	characteristics for ss, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals
		29-30	MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+
3	Fundamentals of Organic Chemistry	31-32	Electronic displacements: Inductive effect, electromeric effect
		33-34	resonance, hyperconjugation. Cleavage of bonds: homolysis and heterolysis.
		35-36	Reaction intermediates: carbocations, carbanions and free radicals. Electrophiles and nucleophiles,
		37-38	Aromaticity: benzenoids and Hückel's rule.
4	Stereochemistry	39-40	Conformations with respect to ethane, butane and cyclohexane, interconversion of Wedge Formula,
		41-42	Newmann, Sawhorse and Fischer representations, concept of chirality (upto two carbon atoms).
		43-44	configuration: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds).
		45-46	Threo and erythro; D and L; cis - trans nomenclature
		47-48	CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z nomenclature (for upto two C=C systems).
5	Aliphatic Hydrocarbons	49-50	Functional group approach for the following reactions: preparations, physical property & chemical reactions to be studied with mechanism in context to their structure.
		51-52	Alkanes: Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical substitution: Halogenation.
		53-54	Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule)
6	Metallic Bond	55-56	cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), addition of HX (Markownikoff's and

			anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration,
		57-58	Hydroborationoxidation. Alkynes: Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides.
		59-60	Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4. Hydration to form carbonyl compounds

Evaluation Scheme:

No.	Component	Duration	Marks
1.	Internal Assessment • Quiz • Class Test • Attendance • Assignment		25
2.	End Semester Examination	3 hr	75

Details of the Course		
Unit	**Contents**	**Contact Hours**
1 Atomic Structure	Review of: Bohr's theory and its limitations, Heisenberg uncertainty principle, Dual behaviour of matter and radiation, De-Broglie's relation, Hydrogen atom spectra, need of a new approach to atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2 , Schrödinger equation for hydrogen atom, radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation), radial and angular nodes and their significance, radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Page 5 of 96 B.Sc. Physical Science Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes, discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.	14
2 Chemical	Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy	16

Bonding and Molecular Structure	and their importance in the context of stability and solubility of ionic compounds, statement of Born-Landé equation for calculation of lattice energy (no derivation), BornHaber cycle and its applications, covalent character in ionic compounds, polarizing power and polarizability, Fajan's rules. Ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H2O, NH3, PCl5, SF6, ClF3, SF4) and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for ss, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+ .	
3 Fundamentals of Organic Chemistry	Electronic displacements: Inductive effect, electromeric effect, resonance, hyperconjugation. Cleavage of bonds: homolysis and heterolysis. Reaction intermediates: carbocations, carbanions and free radicals. Electrophiles and nucleophiles, Aromaticity: benzenoids and Hückel's rule.	8
4 Stereochemistry	Conformations with respect to ethane, butane and cyclohexane, interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations, concept of chirality (upto two carbon atoms). configuration: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z nomenclature (for upto two C=C systems).	10
5 Aliphatic Hydrocarbons	Functional group approach for the following reactions: preparations, physical property & chemical reactions to be studied with mechanism in context to their structure. Alkanes: Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical substitution: Halogenation. Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroborationoxidation. Alkynes: Preparation: Acetylene from CaC2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides and acidity of alkynes, addition of bromine and alkaline KMnO4, ozonolysis and oxidation with hot alk. KMnO4. Hydration to form carbonyl compounds	12
	Total	**60**

Suggested Books:		
Sl. No.	**Name of Authors/Books/Publishers**	**Year of Publication/Reprint**
-1	Lee, J.D. Concise Inorganic Chemistry, Pearson Education	2010
2	Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education	2006
3	Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford	1970
4	Shriver, D.D. & P. Atkins, Inorganic Chemistry 2 and Ed., Oxford University Press	1994
5	Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications	1962
6	Sykes, P.(2005), A Guide Book to Mechanism in Organic Chemistry, Orient Longman.	2005
7	Eliel, E. L. (2000), Stereochemistry of Carbon Compounds, Tata McGraw Hill.	2000
8	Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).	2000
9	Bahl, A; Bahl, B. S. (2012), Advanced Organic Chemistry, S. Chand.	2012
Mode of Evaluation:	Internal Assessment / End Semester Exam	