B.Sc. Semester – II

DSC-3 : Chemistry (Theory)

Course title - Chemistry-2

Course Code: C 2 CHE 1 T 1

After completion of the course (Theory), students will be able to:

CO1: **Explain ionic bond, Born Lande equation, Born Haber cycle and Fagan's rules. State VSEPR theory, hybridization and shapes of various molecules. Understand the concept of resonance and write resonating structures of NO_3^-, CO_3^{2-} and SO_4^{2-}.**

CO2: **Explain MO Theory and draw the MO diagrams for homonuclear diatomic molecules and ions of 1st and 2nd periods and heteronuclear diatomic molecules such as CO, NO and NO^+. Compare MO and VB theory.**

CO3: **Learn preparation and reactions of alkanes, alkenes and alkynes. Clear the concept learning mechanism of Free radical mechanism of halogenations of alkanes. Understand the mechanisms of addition reactions of alkenes and alkynes.**

CO4: **Learn the concept of polymerization, ozonolysis in alkenes and alkynes. Learn acidity of alkynes, formation of metal acetylides and their applications. Explain cycloalkanes and their relative stability. Explain conformational analysis of cyclohexane with Karplus energy diagram. Axial and equatorial bonds. Relative stability of mono substituted cycloalkanes.**

CO5: **Expected to learn symmetry elements, unit cells, crystal systems. Learn Bravais lattice, types and identification of lattice planes. Explain laws of crystallography - law of constancy of interfacial angles, law of rational indices.**

CO6: **Miller indices. X–Ray diffraction by crystals, Bragg's law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Explain defects in crystals. Learn the applications of liquid crystals. Learn the concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates.**

CO7: **Understand the concept of order and molecularity of a reaction and their applications. Define half–life of a reaction. Explain methods for determination of order of a reaction by half life period and differential equation method. Understand the concept of activation energy and its calculation from Arrhenius equation. Explain theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions.**

CO8: **Understand the concept of acid base titration curve, redox curves precipitation titrations and complexometric titrations**

CO9: **students get the knowledge of organic reagents I he analysis of inorganic metal ions.**

Syllabus
DSC-3 : Chemistry 3 (C 2 CHE 1 T 1)

Unit-I: CHEMICAL BONDING & MOLECULAR STRUCTURE.

Ionic Bonding: Review of *general* characteristics of ionic compounds. Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Born-Landé equation and calculation of lattice energy. Born-Haber cycle and its applications. Fajan's rules, ionic character in covalent compounds and percentage of ionic character.

Covalent bonding: VB approach, shapes of inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, (AB2) trigonal planar, (AB3) square planar, (AB4) tetrahedral, trigonal bipyramidal((AB5) and octahedral (AB6) arrangements. Concept of resonance and resonating structures of NO_3^- and CO_3^{2}

Molecular Orbital Theory: LCAO method, bonding and antibonding, Shapes of molecular orbitals, MO treatment of homo nuclear diatomic molecules H_2, He_2 , He_2^+ N_2 , O_2 , O_2^+, O_2^- and hetero nuclear diatomic molecules and ion such as CO and NO (Relationship between bond length, bond order, bond energy, magnetic properties).

Metallic Bond: Physical properties of metals **(**conductivity, luster, malleability & ductility) based on free electron theory. Band theory of metals to explain conductors, insulators, extrinsic and intrinsic semiconductors (including temperature effect).

Unit-II : ALIPHATIC HYDROCARBONS & BASIC CONCEPT IN AROMATICITY

Chemistry of Aliphatic Hydrocarbons:

Aliphatic hydrocarbons: Types - alkanes, alkenes, alkynes and alkadienes.

Alkenes**: mechanism of addition of hydrogen halides and bromine, Markovnikoff's Rule, peroxide effect, acid catalyzed hydration of alkenes (mechanism), oxymercuration–oxidation (Markovnikoff Addition), hydroboration - oxidation (anti-Morkovnikoff's addition), oxidative cleavage of alkenes with $KMnO_4$ and ozone (ozonolysis).**

Alkadienes: classification, mechanism of addition of halogen and hydrogen halides in 1,3-diene, Diels-Alder reaction.

Alkynes: Mechanism of addition of halogen and halogen halides, hydration of alkynes, Acidic character of acetylenic protons (Acidity of 1-alkynes), Comparison of acidic strength of acetylene, ethylene and ethane. oxidative cleavage of alkynes with KMnO4 and ozone (ozonolysis), cyclic polymerization.

Cycloalkanes**:**

Relative stability of cycloalkanes (Baeyer's Strain theory). Conformational analysis of cyclopropane, cyclobutane, cyclopentane and cyclohexane, axial and equatorial bonds, conformation and stability of monosubstituted cyclohexane

Basic Concept in aromaticity:

Criteria for aromaticity: heat of hydrogenation (eg. benzene), resonance and resonance energy (eg. benzene). Huckel's rule with examples such as benzene, furan, thiophene, pyridine, naphthalene, non- benzenoid aromatic compounds- cyclopropenyl cation, cyclopentadienyl anion, and cycloheptatrienyl cation.

Unit-III : CHEMICAL KINETICS AND CHEMICAL & IONIC EQUILIBRIA

Chemical Kinetics: Review of reaction rates.

Orders of reactions. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life period of a reaction for various orders (numerical problems). Methods for determination of order of a reaction by half-life period and Van't Hoff's differential method.

Effect of temperature on reaction rates, temperature coefficient, Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated

Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Numerical problems are to be solved wherever required.

Chemical and Ionic Equilibria:

Law of chemical equilibrium and its thermodynamic derivation. Factors affecting equilibria (Le Chatelier's principle). Relations between K_p, K_c for reactions of formation of ammonia($N_2+3H_2 \rightarrow 2NH_3$). Dissociation of PCl_5($PCl_5 \rightarrow PCl_3+Cl_2$) and synthesis of Sulphur dioxide ($2SO_2+O_2 \rightarrow 2SO_3$). Common ion effect, solubility and solubility product of sparingly soluble salts in qualitative analysis Ex Group II and Group IV radicals

Ionization of acids and bases, hydrolysis of three types of salts and derivation for determination of pH of their solutions. Numerical problems.

Unit-IV: Analytical Chemistry

Titrimetric analysis: Acid base titrations: Principle, role of solvent in acid-base titrations, effect of concentration. Titration curves for strong acid-strong base, weak acid – strong base, weak base –strong acid, , determination of equivalence point – theory of acid base indicators, and colour change range of indicators. Applications for nitrogen, nitrates and carbonates.

Oxidation –Reduction Titrations: Redox process-balancing redox equations, titration curves. Redox indicators, detection of end point, visual indicators and potentiometric end point detection., determination of chemical oxygen demand (COD) in natural and waste waters and other applications.

Precipitation Titration: Principle, Formation constant, Indicators, Mohr's, Volhard and Fajan's method, Applications

Complexometric Titrations: Introduction, a simple complexation titration, titration curves, types of EDTA titrations, metal ion indicators, Applications.

Organic Reagents in Inorganic Analysis: Organic precipitants, general properties, reagents as precipitants.

Recommended Books/References

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd Ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J. J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J. E., Keiter, E.A., Keiter, R.L. & Medhi, O. K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Shriver, D.F. & Atkins, P.W. Inorganic Chemistry, Oxford University Press.
6. Wulfsberg, G. Inorganic Chemistry, Viva Books Pvt. Ltd.
7. Rodgers, G. E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.
8. Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012) Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry. John Wiley & Sons, 1974.
9. G.L. Miessler & Donald A. Tarr: Inorganic Chemistry, Pearson Publication.
10. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
11. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., New York (1985).
12. Organic Chemistry-P. Y. Bruice, 7th Edition, Pearson Education Pvt. Ltd., New Delhi (2013).
13. Heterocyclic Chemistry- R. K. Bansal, 3rd Edition, New- Age International, New Delhi, 2004.
14. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
15. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

16. Stereochemistry-Conformation and Mechanism-P. S. Kalsi, Wiley-Eastern Ltd, New Delhi.
17. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
18. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
19. Graham Solomons, T. W., Fryhle, C. B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
20. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).
21. Organic Chemistry-F. A. Carey, 4th Edition, McGraw Hill (2000).
22. Modern Organic Chemistry - R.O.C. Norman and D.J. Waddington, ELBS, 1983.
23. Understanding Organic reaction mechanisms - A. Jacobs, Cambridge Univ. Press, 1998.
24. Organic Chemistry - L. Ferguson, Von Nostrand, 1985.
25. Organic Chemistry - M. K. Jain, Nagin & Co., 1987.
26. Organic Chemistry- Mehta and Mehta, 2005.
27. Barrow, G.M. Physical Chemistry, Tata McGraw-Hill, 2007.
28. Castellan, G.W. Physical Chemistry, 4th Ed. Narosa, 2004.
29. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi, 2009.
30. P.W. Atkins: Physical Chemistry, 2002.
31. W.J. Moore: Physical Chemistry, 1972.
32. Text Book of Physical Chemistry - P. L. Soni, S. Chand & Co., 1993.
33. Text Book of Physical Chemistry - S. Glasstone, Mackmillan India Ltd., 1982.
34. Principles of Physical Chemistry - B. R. Puri, L. R. Sharma and M. S. Patania, S. L. N. Chand & Co. 1987.
35. Physical Chemistry - Alberty R. A. and Silbey, R. J. John Wiley and sons, 1992.
36. Physical Chemistry - G. M. Barrow, McGraw Hill, 1986.
37. Physical Chemistry (3rd Edition) - Gilbert W. Castilian, Narosa Publishing House, 1985.
38. Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.
39. Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York, 1981.
40. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
41. Willard, H. H., Merritt, L.L., Dean, J. & Settle, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
42. Christian, G.D; Analytical Chemistry, VI Ed. John Wiley & Sons, New York, 2004.
43. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
44. Skoog, D. A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed, 2017.
45. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.

B.Sc. Semester – II

DSC-4 : Chemistry (Practical) 4

Course title - Chemistry-4

Course Code: C 2 CHE 1 P 1

Course Outcome (CO)

After completion of course (Practical), students will be able to:

CO1: Understanding the concepts of titrations in general redox and complexometric titrations in particular

CO2: Learn the analysis technique qualitatively organic compounds with different nature and functional group. To determine the organic compound present in the given solution

CO3: Students learn the idea about the kinetics of the different ordered reactions and the effect of temperature and concentrations on the reaction rate.

Syllabus-

1 Standardization of $KMnO_4$ solution using standard oxalic acid solution and determination of Mohr's salt and water of crystallization in Mohr's salt.

2 Standardization of $K_2Cr_2O_7$ solution using standard Mohr's salt solution and determination of ferrous and ferric ions in a mixture.

3 Standardization of $Na_2S_2O_3$ solution using standard $K_2Cr_2O_7$ solution and determination of iodine in the given solution.

4 Standardization of EDTA solution using standard $ZnSO_4$ solution and determination of magnesium in the given solution.

5 Determination of temporary, permanent and total hardness of water using standard EDTA solution.

Distribution of marks for determination experiments: (15 marks.)
Accuracy - 10(5+5) marks, Technique and presentation - 02 marks, Reactions and Calculations - 03 marks.
Journal -05marks, Viva: 05 marks Total = 40 marks
Deduction of marks for accuracy: : ±0.2 CC – 5 marks, ± 0.4 CC- 04 marks, ±0.6 CC- 03 marks, ±0.8 CC - 02 marks. Above ±1.0 CC -01 mark

Qualitative analysis of solid – solid organic binary mixtures and liquid-liquid binary mixture (by distillation) Experiments 1 to 10
Identification of nature and separation of mixture. Analysis of any one compound through preliminary tests, element test, physical constant, functional group test and preparation of suitable derivative and its physical constant.
Acids: Salicylic, Benzoic acid and Phthalic Acid
Phenol: β–naphthol, α- naphthol
Base: m-nitroaniline and p-nitroaniline.
Neutral: Naphthalene, Acetanilide, Benzamide.

Low Boiling: ethyl acetate, acetone
High Boiling: phenol, aniline, acetophenone, toluene

Experiments 11 & 12 Demonstration Experiments

11 Determination of glycine present in the given solution volumetrically

12 Determination saponification value and iodine number of oil or fat.

Examination

In a batch of ten students, not more than two students should get the same mixture in the practical examination. Viva questions may be asked on any of the experiments prescribed in the practical syllabus. During practical examination chart is not allowed.

Distribution of marks:

Nature and Separation: - 6 marks, Preliminary test and Elemental analysis test: - 6marks, Physical Constant-: 3 marks, Functional Group test 5 marks, Confirmative test 5 marks

Preparation of derivative 5 marks Journal: 5marks, Viva-voce: 5marks. Total marks.40.

Physical Chemistry

1. Study the effect of acid strength on hydrolysis of methyl acetate using HCl and H_2SO_4.

2. Determination of velocity constant and effect of concentration on velocity constant of second order reaction, KI and $K_2S_2O_8$ (a = b).

3.Determine the velocity constant of ethyl acetate by sodium hydroxide (Saponification of ester.)

Distribution of Marks:

Accuracy-18 marks, Technique and Presentation-3marks Calculation and graph- (5+4) 9 marks, Journal-5 marks, Viva-Voce-5 marks, Total=40 marks.

Deduction of Marks for accuracy:

Error up to 5% - 18 marks, 6 - 10%-15 marks, 11-15%- 12 marks, 16-20% 09 marks, above 20% zero (0) marks

General instructions:

In the practical examination, minimum two different preparation and determination experiments may be given. In a batch of ten students, each student will be performing preparation and determination experiments. Selection of experiments may be done by the students based on lots. Viva questions may be asked on any of the experiments prescribed in the practical syllabus**.** *Manual is not allowed in the examination.*

Books recommended:

1. Vogel's Qualitative and quantitative Inorganic Analysis, G.Svehla, 7th Ed, Longman (2001).
2. Advanced Practical Chemistry, Jagadamba Singh, Pragathi, Publications(2001). ,
3. Advanced Practical Inorganic Chemistry, Gurdeep Raj, Goel Publishing House, Meerut(2001).