Saurashtra University, Rajkot

Re-accredited by NAAC
Grade 'A' CGPA 3.05

BSc Semester **III & IV**
Chemistry Syllabus
[With effect from June 2020]

BSc Chemistry Semester III & IV
[2020-21]

CREDITS PER SEMESTER

THEORY: 06 Credits

PRACTICALS: 03 Credits

THEORY - UNIT WISE DISTRIBUTION

Unit-I	Inorganic Chemistry		[12-hours]
Unit-II	Inorganic Chemistry		[08-hours]
Unit-II	Organic Chemistry		[04-hours]
Unit-III	Organic Chemistry		[12-hours]
Unit-IV	Organic Chemistry		[04-hours]
Unit-IV	Physical Chemistry		[08-hours]
Unit-V	Physical Chemistry		[12-hours]
		Total	**: 60 hours**

BSc SEMESTER III CHEMISTRY SYLLABUS [C-301]

Unit-I

1. Basics of Wave mechanics and Applications to MO theory [12 hours]

Introduction of wave Mechanics, Postulates of wave Mechanics, Interpretation of ψ, ψ^2, $\psi\psi^*$, Derivation of Schrodinger's equation in three dimensions (Cartesian Coordination), Eigen function & Eigen value, Orthogonal & Normalized wave function and problems on it, Concept of Molecular Orbital Theory, Characteristic of Molecular Orbital, Wave function of H_2^+ & H_2, Potential energy and Schrodinger's equation for H_2^+ & H_2, Derivation of normalized wave function of H_2^+ based on M.O.T., Hybridization ; Derivation co efficient of wave function of sp, sp^2 & sp^3 Hybridization.

Unit-II

2. Basics of Lanthanide Elements [8 hours]

Introduction, Position in the periodic table, Occurrence & Important ores, Isolation of Lanthanide Elements from ore, Individual Isolation by (I) Ion Exchange Method (II) Solvent Extraction Method, Electronics Configuration with necessary Explanation, Oxidation State & their Stability, Magnetic properties, Color, Isotopes, spectral properties, Lanthanide Contraction, Misch Metal, Uses of Lanthanides & their Compounds.

3 Aryl halides: [4-hours]

Preparation (by direct halogenation, from diazonium salts)

Physical Properties of Aryl Halides

Chemical Reactions of Aryl Halides: Nucleophilic aromatic substitution S_NAr (Benzyne mechanism or Elimination- Addition mechanism)

Other reactions of Aryl halides: Wurtz-Fittig and Fittig reaction, Ullmann reaction, Formation of Organometallic Compounds

Relative reactivity of alkyl halides vs allyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Unit-III

4. Alcohols, Phenol, Ethers & Epoxides [7-hours]

Alcohols Preparation of Monohydric alcohols: from alkyl halides; using Grignard reagent; by reduction of aldehydes, ketones, carboxylic acid and esters.

Physical Properties of alcohols

Chemical Reactions: Reaction with sodium, with carboxylic acids (esterification), with acid chloride & anhydride; Reaction with HX, reaction with PX_5, PX_3, $SOCl_2$; Dehydration of alcohols and Oxidation (with alkaline $KMnO_4$, acidic dichromate, conc. HNO_3)

Distinction between Primary, secondary & tertiary alcohols: Lucas test Victor Meyer Test

Diols: oxidation of diols by periodic acid and lead tetraacetate

Phenol :(Phenol case)
Physical properties; Acidity and factors affecting it;
Reactions: Electrophilic substitution (Nitration, halogenation and sulphonation),
Ethers: Preparation of Ethers by Williamson Synthesis
Reactions: Substitution Reaction [Reaction with Cl_2 in dark & Reaction of Cl_2 in light], Reactions involving C-O bond cleavage [hydrolysis, reaction with H_2SO_4, cold HI & hot HI]
Epoxides: Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$.

5. **Organic Compounds of Nitrogen: [5-hours]**

Amines: Classification of amines (Aliphatic and Aromatic)
Basicity of amines, effect of substituent on basicity of amines
Preparation of amines (by reduction of nitro compounds, ammonolysis of halogen compounds, Reduction of amides, Hoffmann bromamide degradation)
Reactions of primary alkyl & aryl amines: [Reaction with acid chlorides, aryl sulphonyl chlorides, alkylhalides, HNO_2]
Chemical reactions of Aniline: Electrophilic substitution (nitration, bromination, sulphonation), Diazotization of Aniline and reactions of Diazonium salt
Hinsberg Reaction to distinguish between Primary, Secondary and Tertiary amines
Preparation and important reactions of **nitro compounds, nitriles and isonitriles**

Unit-IV

6. **Name Reactions and Rearrangements [4-hours]**

Name Reaction: Reimer-Tiemann reaction, Kolbe's Schmidt reaction, Carbylamine reaction
Rearrangement: Pinacol-Pinacolone Rearrangement, Fries Rearrangement, Claisen Rearrangement,

7. **Phase Equilibrium & Phase Rule: [8 hours]**

Introduction, Criteria of phase equilibrium, Explanation of terms: Phases, Components and Degrees of freedom of a system , Gibbs Phase Rule, Limitations of Phase Rule, Phase Diagram, Phase diagrams of one-component systems (water and sulphur)
Two component systems: Condensed Phase Rule, Eutectics system (Lead-Silver) and Park method of desilverization, Congruent melting point system (Mg – Zn) and Incongruent melting point system (Na - K).

Unit - V

8. **Solutions of Non- Electrolytes: [8 hours]**

Introduction, Factors affecting solubility, Types of solutions, Types of liquid – liquid solutions
Miscible Liquid Pair: Ideal solutions and Raoult's law, Deviations from Raoult's law (Non-ideal solutions), Vapour pressure - composition curves of ideal and non-ideal solutions, Temperature - composition curves of ideal and non-ideal solutions.

Distillation of ideal and non-ideal solutions, Lever rule, Fractional column and Bubble cap tower, Azeotropes.

Immiscible Liquid Pair: Introduction, Principle of steam distillation and its applications.

Numericals,

Solution of Gas in Liquid: Factors affecting solubility of a gas., Effect of pressure (Henry's Law), Numericals.

9. Nernst Distribution Law: [4 hours]

Introduction, Nernst Distribution Law, Its limitations, Modified Nernst Distribution Law [Solute associate in the solvent, Solute dissociate in the solvent, Solute enters into chemical reaction with solvent], Applications, Solvent extraction Numericals

BSc SEMESTER IV CHEMISTRY SYLLABUS [C-401]

Unit-I

1. **Basic Concepts of Organometallic compounds [6 hours]**

   Introduction, Classification based on nature of M-C Bond and heptacity.

   Preparation, Properties and uses of Organo Lithium compounds and organo magnesium compounds

   Preparation, bonding & structure of: Zeise Salts, Tri Methyl aluminium (dimer), Ferrocene

2. **Bioinorganic chemistry [6 hours]**

   Metalloporphyrins, structure and roll of Hemoglobin in biological system, myoglobin, structure of chlorophyll and its importance, toxicity of arsenic, mercury, lead and cadmium, reason for toxicity.

Unit-II

3. **Chemistry of Rare Gas Compounds [8 hours]**

   Introduction, Occurrence, Compounds of inert gas;

   Preparation, structure (VBT) and properties of XeF_2, XeF_4, XeF_6, $XeOF_4$, XeO_2F_2, $XeOF_2$, KrF_2, oxide of xenon – XeO_3, XeO_4, use of Noble gases.

4. **Active methylene compounds: [4-hours]**

   Definition, Keto-enol Tautomerism in Ethyl acetoacetate,

   Preparation of Ethyl acetoacetate [Claisen Condensation with reaction mechanism]

   Chemical Reactions of Ethyl acetoacetate: [Reduction, hydrolysis (with dil. H_2SO_4, with ethanolic KOH), with sodium ethoxide, reaction with alkylhalide, Reaction with $NaHSO_3$ and HCN, reaction with Aldehydes]

   Synthesis from Ethyl acetoacetate

   - Monocarboxylic acid: Butyric acid and Valeric acid
   - Ketone: 2-Pentanone and 3- Methyl 2-pentanone
   - α, β – unsaturated acid: Crotonic acid
   - Dicarboxylic acid: Adipic acid
   - Diketone: Acetyl acetone and Acetonyl acetone,
   - Keto acid: Levulenic acid

Unit-III

5. **Chemistry of Carbonyl Compounds (Aldehydes & Ketones): [6-hours]**

   Structure, reactivity, Nature of carbonyl group,

   Preparation of aldehydes: by oxidation of alcohols, from alkenes, from acid chlorides and from nitriles.

   Preparation of Ketones: by oxidation of alcohols, from alkenes, from acid chlorides, by Fries Rearrangement.

   Reactions of Aldehydes & Ketones: Nucleophilic additions (with HCN, ROH, $NaHSO_3$), Nucleophilic addition-elimination reactions (with ammonia derivatives with mechanism), oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$,)

6. **Chemistry Carboxylic Acids and their Derivatives: [6-hours]**

Carboxylic acids:

Acidity of Carboxylic acids, Effect of substituents on Acidity of carboxylic acids
Preparation of monocarboxylic acids (by hydrolysis of acid derivatives)
Reactions of monocarboxylic acids: Salt formation, Decarboxylation, Reduction, α-Halogenation – Hell Volhard Zelinsky Reaction

Carboxylic acid derivatives

Preparation of Acid chlorides, Anhydrides, Esters and Amides from carboxylic acids and their inter-conversion
Mechanism of Esterification
Hydrolysis of Esters ($B_{AC}2$ Mechanism)

Unit-IV

7. **Name Reaction and Rearrangements-II: [4-hours]**

Name Reaction: Aldol condensation, Perkin Reaction, Wittig reaction
Rearrangement: Beckmann Rearrangement, Benzil-Benzilic acid Rearrangement, and Hofmann bromamide degradation.

8. **Study of Physical Properties [8-hours.]**

Introduction

Types of Physical Properties: Additive and Constitutive Properties
Molar Volume: Kopp's Law, Atomic Volume
Surface Tension: Explanation of Surface Tension, Name of Methods to Determine Surface Tension, The Drop Weight Method
Parachor: Macleod Equation and $P_1/P_2 = V_1/V_2$, Atomic Parachor, To Determine Structure of (i) Quinine (ii) Benzene (iii) Isocyanides group (iv) Nitro group
Viscosity: Explanation (Briefly), Unit and Factors Affecting the Viscosity, Measurement of Viscosity (Derivation of $\eta_1 / \eta_2 = d_1t_1 / d_2t_2$), Ostwald's Viscometer
Refractive Index and Refractivity: Introduction, Specific and Molecular Refractivity, Abbe Refractometer, Molecular Refractivity and Chemical Constitution
Optical Activity: Polarization of Light, Optical Activity,Factors Affecting Angle of Rotation, Specific Rotation, Polarimeter
Dipole Moment: Polar and Non-polar molecule,Electric Polarization (Polarizability of Molecules), The Mosotti Clausious Equation, Kinds of Molar Polarization [Electron & Nuclear Polarization, Orientation Polarization (Permanent Dipole Moment)]; Application of Dipole Moment: Identification of Polar and Non-polar molecules, Molecular Structure :(i) Mono atomic molecules, (ii) Diatomic molecules (iii) Triatomic molecules (CO_2, H_2O, SO_2) (iv) Tetratomic molecules (NH_3, BCl_3) (v) Aromatic Compounds (Benzene) (vi) Resonance Structure (N_2O) (vii) Cis-Trans Isomer (viii) Orientations in Organic Molecules (o, m and p substitution),
Numericals

Unit - V

9. Thermochemistry & Thermodynamics: [12 hours]

Introduction, Limitations and Advantages of Thermodynamics, Types of Systems State Variables, properties of System: Extensive and Extensive Properties, Types of Processes, State and Path Functions, Exact and Inexact Differential Concept of Heat, Work and Internal Energy, First Law of Thermodynamics: Statements, Mathematical derivation, Heat absorbed at constant volume, Perpetual Machine of First Kind, Enthalpy, Heat Capacity: Its types and derivation of relation ($C_p - C_v = R$), Isothermal Reversible and Irreversible Work of Ideal Gas, Proof: $W_r > W_{irr}$, Relations between P – V, V – T and T – P for Adibatic Process, Adiabatic Reversible and Irreversible work of Ideal Gas, Joule Thomson Effect, Joule Thomson Coefficient, Joule Thomson of Ideal Gas, Zeroth Law (Only Statement and Explanation), Variation of Enthalpy with Temperature (Kirchhoff Equation), Flame and Explosion Temperature, Numericals

REFERENCE BOOKS:

1. Quantum chemistry by A. K. Chandra
2. Basic Concept of Quantum Chemistry by R. K. Das.
3. UGC Inorganic Chemistry - H. C. Khera (Pragati Prakashan)
4. Principles of Inorganic chemistry – Puri, Sharma & Kalia.
5. Concise Inorganic Chemistry - J. D. Lee
6. Advanced Inorganic Chemistry- Cotton and Wilkinson
7. Basic Inorganic Chemistry - Gurdeep & Chatwal
8. Organic Chemistry Vol-I&II, by Dr. Jagdamba Singh & Dr. L.D.S. Yadav (Pragati Prakashan)
9. Organic Chemistry (Volume I, II & III) by S.M. Mukherji, S.P. Singh and R.P. Kapoor
10. A Text Book of Organic Chemistry (II Edition) by Raj K. Bansal
11. Organic Chemistry by Clayden
12. Name Reactions in Organic Synthesis by Dr. A.R.Parikh et. al
13. Organic Reaction Mechanisms by V.K. Ahluwalia
14. Reactions and Rearrangements by Gurdeep Chatwal
15. Essentials of Physical Chemistry, B. S. Bahl, G. D. Tuli and Arun Bahl, S. Chand & Co.. New Delhi.
16. Elements of Physical Chemistry, Late B.R. Puri, L. R. Sharma and Madan Pathania, Vishal Publishing Co. Jalandhar.
17. Principles of Physical Chemistry, Samule H. Maron and Carl F. Prutton, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
18. Physical Chemistry, B. K. Sharma, Goel Publication House. Meerut.
19. Elements of Physical Chemistry, Samuel Glasstone and David Lewis, Macmillan & Co.
20. Molecular Physical Chemistry by McQuarrie

PAPER STYLE – THEORY [C-301 & C-401]

INSTRUCTIONS TO PAPER SETTERS

1. B. Sc. Chemistry Syllabus for Semester III & IV (WEF 2020-2021) consists of **FIVE** units
2. All the units carry equal weightage (14 Marks each)
3. There must be one question from each unit.
4. Each subtopic must be given due weightage in question paper (as per the No. of hours of classroom teaching allocated for each unit)
5. 70 Marks for Semester Examination & 30 marks for Internal Examinations.
6. Time duration: 2 ½ Hours

Question 1: Answer the following (UNIT-I)

a. Four objective questions each of one Mark : 1x4 = 4
b. Answer any one out two each of two Marks : 1x2 = 2
c. Answer any one out two each of three Marks : 1x3 = 3
d. Answer any one out two each of five Marks : 1x5 = 5

Total Marks: 14

Question 2: Answer the following (UNIT-II)

a. Four objective questions each of one Mark : 1x4 = 4
b. Answer any one out two each of two Marks : 1x2 = 2
c. Answer any one out two each of three Marks : 1x3 = 3
d. Answer any one out two each of five Marks : 1x5 = 5

Total Marks: 14

Question 3: Answer the following (UNIT-III)

a. Four objective questions each of one Mark : 1x4 = 4
b. Answer any one out two each of two Marks : 1x2 = 2
c. Answer any one out two each of three Marks : 1x3 = 3
d. Answer any one out two each of five Marks : 1x5 = 5

Total Marks: 14

Question 4: Answer the following (UNIT-IV)

a. Four objective questions each of one Mark : 1x4 = 4
b. Answer any one out two each of two Marks : 1x2 = 2
c. Answer any one out two each of three Marks :1x3 = 3
d. Answer any one out two each of five Marks : 1x5 = 5

Total Marks: 14

Question 5: Answer the following (UNIT-V)

a. Four objective questions each of one Mark : 1x4 = 4
b. Answer any one out two each of two Marks : 1x2 = 2
c. Answer any one out two each of three Marks : 1x3 = 3
d. Answer any one out two each of five Marks : 1x5 = 5

Total Marks: 14

CHEMISTRY PRACTICALS
(No of Credits: 3 for each semester)

CHEMISTRY PRACTICALS

CHEMISTRY PRACTICALS SEMESTER III [C 302]

1. **Organic Qualitative Analysis [minimum 10]**
   [Minimum ten organic mixtures should be analyzed & recorded by the students; of which minimum should be six bifunctional]
   Identification of an organic compound through the functional group analysis and determination of melting point or boiling point

2. Organic Volumetric Estimation: [Standard solution to be given]

1. To determine the amount of $-CONH_2$ in the given Acetamide solution
2. To determine the amount of Phenol / m-cresol in the given solution
3. To determine the amount of Aniline / p-toludine in the given solution
4. To determine the amount of Ester in the given solution
5. To determine the amount of Glucose in the given solution
6. To determine the amount of –COOH in the given carboxylic acid

PAPER STYLE – PRACTICALS

CHEMISTRY PRACTICALS SEMESTER III [C 302]

Internal Evaluation [CCA]: 15 Marks

[Based on: performance in the laboratory, submission of record book, journal writing & submission and attendance]

External Evaluation [SSE]: 35 Marks

[Duration of Examination- 3 ½ hours]

Exercise – I: Organic Qualitative Analysis - 20 marks

Exercise – II: Organic Volumetric Estimation- 15 marks

CHEMISTRY PRACTICALS SEMESTER IV [C 402]

1. **Inorganic Qualitative Analysis**:
   [Minimum ten inorganic mixtures should be analyzed and recorded by the students]
   Qualitative Analysis of an inorganic mixture containing four radicals, excluding PO_4^{-3}, CrO_4^{-2}, $Cr_2O_7^{-2}$, AsO_3^{-3}, AsO_4^{-3}, BO_3^{-3} and S^{-2}

2. **Physicochemical Exercise**
   1. To determine the specific reaction rate of the hydrolysis of methyl acetate / Ethyl acetate catalyzed by H^+ ion at room temperature.
   2. To study the rate of reaction between $K_2S_2O_8$ and KI.
   3. To study the rate of reaction between $KBrO_3$ and KI.
   4. To determine the temperature coefficient and Energy of activation for the hydrolysis of ester at two different temperatures.
   5. To determine the temperature coefficient and Energy of activation for the reaction between $K_2S_2O_8$ and KI at two different temperatures
   6. To determine the rate of adsorption of the given organic acid using animal charcoal.
   7. Distribution Law: To study the partition co-efficient of benzoic acid between water and benzene / kerosene and hence study the molecular condition of benzoic acid in the solution.
   8. To study the partition co-efficient of acetic acid between water and chloroform and hence study the molecular condition of acetic acid in the solution.

PAPER STYLE – PRACTICALS

CHEMISTRY PRACTICALS SEMESTER IV [C 402]

Internal Evaluation [CCA]: 15 Marks

[Based on: performance in the laboratory, submission of record book, journal writing & submission and attendance]

External Evaluation [SSE]: 35 Marks

[Duration of Examination- 3 ½ hours]

Exercise – I: Inorganic Qualitative Analysis - 20 marks

Exercise – II: Physicochemical Exercise- 15 marks