B.Sc. Part- II (Semester- III)
3S Chemistry

Total Lectures: 84 **Marks: 80**

Unit I (14L)

A] Covalent Bonding:

Molecular Orbital Theory. Postulates of MO theory. LCAO approximation. Formation of bonding and antibonding MOs. Rules for LCAO. MO energy level diagram. Concept of bond order. MO structure of homonuclear diatomic molecules of namely He_2, H_2, N_2 and O_2. Stability sequence of species of O_2 i.e., O_2, O^{2+}, O_2^{2+}, O_2^- and O_2^{2-}. Paramagnetic nature of O_2. MO structure of heteronuclear diatomic molecules viz. NO, HF and CO (Coulson's structure). Explanation of important properties of CO viz. – triple bond, almost nonpolar nature, electron donor and acceptor behaviour. Comparison of VB and MO theories. **[6]**

B] Metallic Bonding:

Free electron theory and properties of metals such as electrical and thermal conduction, malleability, ductility and metallic lusture. VB theory or Resonance theory of metals. Band theory to explain nature of conductors, insulators and semiconductors (both intrinsic and extrinsic).

[3]

C] VSEPR Theory:

Various rules under VSEPR theory to explain molecular geometry (following examples may be taken to explain various rules- $BeCl_2$, BF_3, CH_4 , NH_4^+ , PCl_5 , SF_6, IF_7, $SnCl_2$, NH_3, H_2O, SF_4, ClF_3, BrF_5, XeF_6, SOF_4, COF_2, PCl_3). Limitations of VSEPR theory.

[5]

Unit II - Theory of Quantitative Inorganic Analysis (14L)

A] Volumetric Analysis:

(a) Introduction: -Volumetric analysis, titrant, titrate, end point, equivalence point, indicator etc. Requirements of volumetric analysis. Definition of standard solution, primary standard substance. Requirements of primary standard substance. Terms to express concentrations namely - molarity, normality, molality, mole fraction and percentage. (Simple numericals expected).

(b) Acid-Base Titrations: - Types of acid base titrations. pH variations during acid base titration. Acid base indicators. Modern theory (Quinoniod theory) of acid base indicators. Choice of suitable indicators for different acid base titrations.

(c) Redox Titrations: -General principles involved in redox titrations (redox reactions, redox potentials, oxidant, reductant, oxidation number). Brief idea about use of $KMnO_4$, $K_2Cr_2O_7$ as oxidants in acidic medium in redox titrations. Use of I_2 in iodometry and iodimetry. Redox indicators-external and internal indicators. Use of starch as an indicator. Iodometric estimation of Cu (II). **[8]**

B] Gravimetric Analysis:

Definition. Theoretical principles underlying various steps involved in gravimetric analysis with reference to estimation of barium as barium sulphate. Coprecipitation and post precipitation. (Definition, types and factors affecting). **[6]**

Unit III (14L)

A] Aldehydes and Ketones:

Preparation of acetaldehyde from ethanol, ethylidene chloride and acetylene. Preparation of benzaldehyde from benzene (Gattermann - Koch reaction) and toluene. Preparation of acetone from isopropyl alcohol, isopropylidene chloride and propyne. Preparation of acetophenone from benzene and ethyl benzene.

Structure of carbonyl group, acidity of α-hydrogen in carbonyl compounds.

Reactions of aldehydes &/or ketones: Cannizaro's, Reformatsky, Perkin with mechanism, Mannich reaction, Benzoin and Aldol condensations. Clemmensen, Wolf-Kishner, MPV and $LiAlH_4$ reductions. **[8]**

B] Carboxylic acids:

Structure and reactivity of carboxylic groups. Acidity of carboxylic acids, effects of substituents on acids strength.

Oxalic acid: Preparation from ethylene glycol and cyanogen.

Reactions: Reaction with ethyl alcohol, ammonia, glycerol and action of heat.

Lactic acid: Preparation from acetaldehyde and pyruvic acid.

Reactions: Reaction with ethanol, PCl_5, action of heat, oxidation and reduction.

Benzoic acid: Preparation from toluene, benzyl alcohol, phenyl cyanide and benzamide. Reactions : Reaction with ethanol, PCl_5 and ammonia.

Salicylic acid: Preparation by Reimer-Tiemann reaction.

Reactions: Reaction with CH_3COCl, CH_3OH and C_6H_5OH. **[6]**

Unit IV (14L)

A] Optical isomerism:

Element of symmetry, chirality, asymmetric carbon atom, enantiomers, Distereoisomers, relative and absolute configurations, DL and RS nomenclature, racemisation and resolution (by chemical method). **[4]**

B] Geometrical isomerism:

Cis-trans & *E-Z* nomenclature, Methods of structure determination. **[3]**

C] Conformational isomerism:

Bayer's Strain theory and its limitations. Stability of cycloalkanes, conformational isomers of ethane, n-butane and cyclohexane, their energy level diagrams. Newman & Sawhors projection formulae. **[7]**

Unit V (14L)

A] Thermodynamics and Equilibrium: **[10]**

(i) Gibb's and Helmholtz's free energy function. Physical significance of Gibb's free energy, Change in free energy as a criteria of spontaneity and equilibrium. Variation of free energy G with P & T. Gibb's-Helmholtz's equation in terms of G and its application. (ii) Partial molal function, chemical potential, derivations of Gibb's-Duhem equation. Chemical potential of an ideal gas in gaseous mixture. Derivation of Vant Hoff's isotherm and its application to equilibrium state. Derivation of vant Hoff's equation and its applications. (iii) Numericals.

B] Phase Equillibrium: **[4]**

(i) Immiscible liquids, Nerst distribution law and its application to association and dissociation of solute in one of the solvents. Process of extraction, derivation of formula for the amount of solute left unextracted after nth extraction. (ii) Phase transition - Clausius-Clyperon equation

(only qualitative statement). (iii) Partially miscible liquids - Phase diagram of phenol-water, triethyl amine - water and nicotine-water systems. (iv) Numericals.

Unit VI (14L)

A] Liquid state: [4]

(i) Surface tension, determination and its S.I. Unit. Effect of temperature on surface tension, derivation of expression for relative surface tension by Drop number method. Application of surface tension. (ii) Viscosity, determination and its S.I. Unit. Effect of temperature on viscosity, derivation of expression for relative viscosity by Ostwald's viscometer method. Applications of viscosity.

B] Electrochemistry: [10]

(i) Conductance of electrolyte solution. Specific, equivalent and molar conductance. Determination of conductance of electrolyte solution, variation of specific and equivalent conductance with dilution for strong electrolyte. Conductometric titrations. Applications of conductometric titration. (ii) Migration of ions under the influence of electric field. Transport number of ions. Determination of transport number by Hottorf's method and Moving boundary method (iii) Kohlrausch's law of independent migration of ions. Determination of l¥ and degree of dissociation a of a weak electrolyte. Determination of dissociation constant of weak electrolyte. (iv) Numericals.

Semester- III

3S Chemistry Practical's

Total Laboratory sessions: 26

Marks: 50

Exercise I: 16 Laboratory sessions

a) Volumetric Analysis

1) Prepare 0.1N oxalic acid standard solution and find out the acid neutralizing capacity of an antacid using NaOH as an intermediate solution.

2) Prepare 0.1N H_2SO_4 solution and find out its exact normality using NaOH as an intermediate solution and 0.1N oxalic acid as standard solution.

3) To determine the strength of oxalic acid by titration with $KMnO_4$.

4) To determine percentage purity of Ferrous Ammonium Sulphate (FAS) by titration with $KMnO_4$.

5) To determine strength of FAS by titration with $K_2Cr_2O_7$ using internal indicator.

6) To determine strength of $K_2Cr_2O_7$ by titration with FAS using internal indicator.

7) Estimation of copper (II) in commercial copper sulphate sample by iodometric titration.

b) Gravimetric Analysis

Estimation of Ba^{2+} as $BaSO_4$, Fe^{3+} as Fe_2O_3 using China and silica crucible and Ni^{2+} as Ni-DMG using sintered glass crucible.

Exercise II: Physical Chemistry experiments **10 Laboratory sessions**

1) To determine refractive index by Abbe's refractometer.
2) To construct phase diagram of phenol-water system and to determine consolute temperature for the system.
3) To determine transition temperature of $MnCl_2.4H_2O$.
4) To study kinetics of hydrolysis of methyl acetate catalysed by acid.
5) To study kinetics of saponification of ethyl acetate by NaOH. (Equal concentration)
6) To determine partition coefficient of benzoic acid between benzene and water.
7) To determine partition coefficient of iodine between CCl4/Kerosene and water.
8) To determine solubility of benzoic acid at different temperature and heat of solution.

B.Sc. Part-II (Semester – IV)

4S Chemistry

Total Lectures: 84 **Marks: 80**

Unit I (14L)

A] Chemistry of elements of transition series: [11]

Definition of transition elements. General characteristics of transition elements. Comparative study of first transition series elements (3d) with reference to following properties: (i) Electronic configuration (ii) Atomic and ionic size (iii) Ionization energy (iv) Metallic nature (v) Oxidation states (vi) Magnetic properties (vii) Color of salts (viii) Catalytic properties (ix) Complex formation behaviour. Study of 4d and 5d series elements-Electronic configuration. Comparison of 3d series elements with 4d and 5d series elements with respect to size, oxidation states, magnetic properties and color.

B] Extraction of elements: [3]

Principles involved in extraction of elements. Major methods of extraction of elements. Factors affecting choice of extraction method. Thermodynamics of reduction processes-Ellingham diagrams for oxides and importance of this diagram (only preliminary ideas).

Unit II (14L)

A] Inner Transition elements: **[11]**

Definition, Lanthanides and Actinides. Comparative study of Lanthanides with respect to following properties:(i) Electronic configuration (ii) Atomic and ionic radii lanthanide contraction definition, cause and effect of lanthanide contraction (iii) Oxidation states (iv) Magnetic properties (v) Color of salts (vi) Complex formation behaviour. Occurrence of lanthanides. Isolation of lanthanides by ion exchange method. Actinides – Electronic configuration and oxidation states. Comparison of lanthanides and actinides.

B] General Principles of Metallurgy: **[3]**

Definition of metallurgy, steps in metallurgy. Ore dressing by gravity separation, froath floatation and electromagnetic separation. Calcination, roasting, smelting and refining of metals. Meaning of terms hydrometallurgy and pyrometallurgy.

Unit III (14L)

A] Polynuclear hydrocarbons: **[4]**

Naphthalene - Haworth synthesis, orbital picture, Reactions – electrophilic substitution (orientation) Preparation of naphthols from naphthalene sulphonic acids and naphthylamines from naphthols.

B] Reactive methylene compounds: **[6]**

Malonic Ester: Synthesis from acetic acid, Synthetic applications - Synthesis of acetic acid, succinic acid, glutaric acid, crotonic acid and malonyl urea. Acetoacetic ester: Synthesis from ethyl acetate, Synthetic applications- Synthesis of acetic acid, propionic acid, isobutyric acid, succinic acid, glutaric acid, crotonic acid, acetyl acetone and 4-methyl uracil.

C] Carbohydrates: **[4]**

Constitution of glucose, cyclic structure, Pyranose and Furanose structure, Epimerization, conversion of glucose to fructose and vice-versa, Introduction to fructose, ribose, 2-deoxyribose, maltose, sucrose. (Their structures only, determination not needed).

Unit IV (14L)

A] Aromatic nitro compounds: **[3]**

Nitrobenzene: Synthesis from benzene, Reduction of nitrobenzene in acidic, neutral and alkaline medium.

B] Amino Compounds: **[4]**

Basicity and effect of substituents. Methods of preparation of aniline from nitrobenzene, Reactions: with acetyl and benzoyl chlorides, Br_2 (aq) and Br_2 (CS_2), Carbylamine reaction, alkylation, Hoffmann's exhaustive methylation and its mechanism.

C] Diazonium Salts: [3]

Preparation benzene diazonium chloride, Synthetic applications - Preparation of benzene, phenol, halobenzene, nitrobenzene, benzonitrile, coupling with phenol and aniline.

D] Amino acids and Proteins: [4]

Classification, Strecker and Gabrial phthalimide synthesis, Zwitter ion structure, Isoelectric point, peptide synthesis, Structure determination of polypeptides by end group analysis

Unit V - Colligative Properties of Dilute Solutions: (14L)

(i) Defination and examples of colligative properties. (ii) Elevation of boiling point, thermodynamic derivation of the relationship between elevation of boiling point and molar mass of a non-volatile solute. Cottrell's method for determination of elevation of boiling point. (iii) Depression of freezing point, thermodynamic derivation of the relationship between depression of freezing point and molar mass of a non-volatile solute. Rast's method for determination of depression of freezing point. (iv) Abnormal behavior of solution. Van't Hoff's factor 'i'. Determination of degree of association and dissociation from
Van't Hoff's factor. (v) Numericals.

Unit VI - Crystalline state (14L)

Symmetry in crystal, plane of symmetry, axis of symmetry and point of symmetry. Law of constancy of interfacial angles. Elements of symmetry in cubic crystals. Laws of symmetry. Law of rational indices, Weiss and Miller indices of a lattice planes, calculation of interplaner distance d(h,k,l) from Miller indices in a cubic system. Seven crystal systems and fourteen Bravais lattices, Bravais lattices of cubic system. Simple cubic system (S.C.C.),
body centered cubic system (B.C.C.) and face centered cubic system (F.C.C.). Calculation of number of constituent units in S.C.C., B.C.C. and F.C.C. Ratio of interplaner distances for 100, 110 and 111 lattice plane in S.C.C., B.C.C. and F.C.C. (No geometrical derivation). Derivation of Bragg's equation for X-ray diffraction, Bragg's X-ray spectrometer method for the determination of crystal structure of NaCl and KCl. Anomalous behaviour of KCl towards X-ray. Numericals.

Semester - IV

4S Chemistry Practical's

Total Laboratory sessions: 26 **Marks: 50**

Exercise I: Inorganic estimations **14 Laboratory sessions**

1) Chromatographic separation of binary mixture containing Cu (II), Co (II) and Ni (II) ions by paper chromatography and determination of Rf values.
2) Estimation of Zn (II) by complexometric titration.
3) To determine the strength of calcium salt solution by complexometric titration.
4) Estimation of hardness of water by complexometric titration.
5) Colorimetric or spectrophotometric estimation of Cu (II) in commercial copper sulphate sample as ammonia complex.
6) To determination of concentration of unknown $KMnO_4$ solution from standard solutions of $KMnO_4$ by colorimetrically or spectrophotometrically.

Exercise II: Organic Chemistry Practical's **12 Laboratory Sessions**

1. Isolation of casein from milk.
2. Isolation of nicotine from tobacco leaves.
3. Isolation of caffeine from tea leaves.
4. Isolation of lycopene from tomato juice.
5. Estimation of glucose.
6. Estimation of acetamide.
7. Determination of equivalent weight of an organic acid.