

## SECOND YEAR

### PAPER - II

#### UNIT - I : Inorganic Chemistry - I

- I. Chemistry of d-block elements :** Characteristics of d-block elements with special reference to electronic configuration, variable valence, magnetic properties, catalytic properties and ability to form complexes. Stability of various oxidation states and e.m.f. Comparative treatment of second and third transition series with their 3d analogues. Study of Ti, Cr and Cu triods in respect of electronic configuration and reactivity of different oxidation states.
- II. Chemistry of f-block elements:** Chemistry of lanthanides - electronic structure, oxidation states, lanthanide contraction, consequences of lanthanide contraction, magnetic properties, spectral properties and separation of lanthanides by ion exchange and solvent extraction methods. Chemistry of actinides - electronic configuration, oxidation states, actinide contraction, position of actinides in the periodic table, comparison with lanthanides in terms of magnetic properties, spectral properties and complex formation.
- III. Theories of bonding in metals :** Valence bond theory, Explanation of metallic properties and its limitations, Free electron theory, thermal and electrical conductivity of metals, limitations, Band theory, formation of bands, explanation of conductors, semiconductors and insulators.
- IV. Metal carbonyls and related compounds - EAN rule,** classification of metal carbonyls, structures and shapes of metal carbonyls of V, Cr, Mn, Fe, Co and Ni. Metal nitrosyls and metallocenes (only ferrocene).

#### UNIT - II : Organic Chemistry - II

##### 1. Halogen compounds

Nomenclature and classification of alkyl (into primary, secondary, tertiary), aryl, aralkyl, allyl, vinyl, benzyl halides.

Chemical Reactivity, formation of RMgX

Nucleophilic aliphatic substitution reaction-classification into  $S_N^1$  and  $S_N^2$ .

Energy profile diagram of  $S_N1$  and  $S_N2$  reactions. Stereochemistry of  $S_N2$  (Walden inversion)  $S_N1$  (Racemisation). Explanation of both by taking the example of optically active alkyl halide - 2-bromobutane. Ease of hydrolysis - comparison of alkyl, benzyl, allyl, vinyl and aryl halides

## 2. Hydroxy compounds

Nomenclature and classification of hydroxy compounds.

Alcohol: Preparation with hydroboration reaction, Grignard synthesis of alcohols.

Phenols : Preparation i) from diazonium salt, ii) from aryl sulphonates, iii) from cumene.

Physical properties- Hydrogen bonding (intermolecular and intramolecular). Effect of hydrogen bonding on boiling point and solubility in water.

Chemical properties :

- acidic nature of phenols.
- formation of alkoxides/phenoxides and their reaction with RX.
- replacement of OH by X using  $PCl_5$ ,  $PCl_3$ ,  $PBr_3$ ,  $SOCl_2$  and with HX/ $ZnCl_2$ .
- esterification by acids (mechanism).
- dehydration of alcohols.
- oxidation of alcohols by  $CrO_3$ ,  $KMnO_4$
- special reaction of phenols: Bromination, Kolbe-Schmidt reaction, Reimer-Tiemann reaction, Fries rearrangement, Azocoupling.

Identification of alcohols by oxidation with  $KMnO_4$ , ceric ammonium nitrate, Lucas reagent and phenols by reaction with  $FeCl_3$ .

Polyhydroxy compounds: Pinacol-Pinacolone rearrangement.

## 3. Carbonyl compounds

Nomenclature of aliphatic and aromatic carbonyl compounds, structure of the carbonyl group.

Synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids.

Physical properties: absence of hydrogen bonding, keto-enol tautomerism, reactivity of carbonyl group in aldehydes and ketones.

Nucleophilic addition reaction with a)  $\text{NaHSO}_3$ , b)  $\text{HCN}$ , c)  $\text{RMgX}$ , d)  $\text{NH}_2\text{OH}$ , e)  $\text{PhNHNH}_2$ , f) 2,4-DNPH, g) Alcohols-formation of hemiacetal and acetal.

Halogenation using  $\text{PCl}_5$  with mechanism.

Base catalysed reactions: a) Aldol, b) Cannizzaro reaction, c) Perkin reaction, d) Benzoin condensation, e) Haloform reaction, f) Knoevenagel reaction.

Oxidation of aldehydes- Baeyer- Villiger oxidation of ketones.

Reduction: Clemmensen reduction, Wolf-Kishner reduction, MPV reduction, reduction with  $\text{LiAlH}_4$  and  $\text{NaBH}_4$ .

Analysis of aldehydes and ketones with a) 2,4-DNP test, b) Tollen's test, c) Fehling test, d) Schiff test, e) Haloform test (with equation).

#### 4. Carboxylic acids and derivatives

Nomenclature, classification and structure of carboxylic acids.

Methods of preparation by

- hydrolysis of nitriles, amides and esters.
- carbonation of Grignard reagents.

Special methods of preparation of aromatic acids by

- oxidation of side chain.
- hydrolysis by benzotrichlorides
- Kolbe reaction

Physical properties: Hydrogen bonding, dimeric association, acidity-strength of acids with examples of trimethyl acetic acid and trichloroacetic acid. Relative differences in the acidities of aromatic and aliphatic acids.

Chemical properties: Reactions involving H, OH and COOH groups-salt formation, anhydride formation, acid chloride formation, amide formation and esterification (mechanism). Degradation of carboxylic acids by Huns-Diecker reaction, decarboxylation by Schimdt reaction, Arndt-Eistert synthesis, halogenation by Hell-Volhard-Zelinsky reaction

Derivatives of carboxylic acids: Reaction of acid chlorides, acid anhydrides, acid amides, esters (mechanism of the hydrolysis of esters by acids and bases).

## 5. Active methylene compounds

Acetoacetic esters: preparation by Claisen condensation, keto-enol tautomerism. Acid hydrolysis and ketonic hydrolysis.

hydrolysis and ketonic hydrolysis.

Preparation of

- a) monocarboxylic acids
- b) dicarboxylic acids.

Reaction with urea

Malonic ester: preparation from acetic acid.

Synthetic applications: Preparation of

- a) monocarboxylic acids (propionic acid and n-butyric acid).
- b) dicarboxylic acids (succinic acid and adipic acid).
- c)  $\alpha,\beta$ -unsaturated carboxylic acids (crotonic acid).

Reaction with urea.

## 6. Exercises in interconversion

### UNIT - III : Physical chemistry - II

#### 1. Phase rule

Concept of phase, components, degree of freedom. Definition of Gibbs phase rule. Phase equilibrium of one component - water system. Phase equilibrium of two-component system, solid-liquid equilibrium. Simple eutectic diagram of Pb-Ag system, desilverisation of lead. Solid solutions- compound with congruent melting point- (Mg-Zn) system, compound with incongruent melting point - NaCl- water system. Freezing mixtures.

#### 2. Dilute solutions

Colligative properties. Raoult's law, relative lowering of vapour pressure, its relation to molecular weight of non-volatile solute. Elevation of boiling point and depression of freezing point. Derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods of determination. Osmosis, osmotic pressure, experimental determination. Theory of dilute solutions. Determination of

molecular weight of non-volatile solute from osmotic pressure. Abnormal Colligative properties. Van't Hoff factor, degree of dissociation and association.

### 3. **Electrochemistry**

Specific conductance, equivalent conductance, measurement of equivalent conductance. Variation of equivalent conductance with dilution. Migration of ions, Kohlrausch's law. Arrhenius theory of electrolyte dissociation and its limitations. Ostwald's dilution law. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Definition of transport number, determination by Hittorf's method. Application of conductivity measurements-determination of dissociation constant ( $K_a$ ) of an acid, determination of solubility product of sparingly soluble salt, conductometric titrations.

Types of reversible electrodes- the gas electrode, metal-metal ion, metal-insoluble salt and redox electrodes. Electrode reactions, Nernst equation, single electrode potential, standard Hydrogen electrode, reference electrodes, standard electrode potential, sign convention, electrochemical series and its significance. Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurements. Computation of cell EMF. Applications of EMF measurements, Calculation of thermodynamic quantities of cell reactions ( $\Delta G$ ,  $\Delta H$  and  $K$ ). Determination of pH using quinhydrone electrode, Solubility product of AgCl. Potentiometric titrations.

## **UNIT - IV : General Chemistry - II**

### 1. **Molecular symmetry**

Concept of symmetry in chemistry-symmetry operations, symmetry elements. Rotational axis of symmetry and types of rotational axes. Planes of symmetry and types of planes. Improper rotational axis of symmetry. Inversion centre. Identity element. The symmetry operations of a molecule form a group. Flow chart for the identification of molecular point group.

### 2. **Theory of quantitative analysis**

a Principles of volumetric analysis. Theories of acid-base, redox, complexometric, iodometric and precipitation titrations, choice of indicators for these titrations.

- b) Principles of gravimetric analysis: precipitation, coagulation, peptization, coprecipitation, post precipitation, digestion, filtration and washing of precipitate, drying and ignition, precipitation from homogeneous solutions, requirements of gravimetric analysis.

### 3. Evaluation of analytical data

Theory of errors, idea of significant figures and its importance, accuracy - methods of expressing accuracy, error analysis and minimization of errors, precision - methods of expressing precision, standard deviation and confidence limit.

### 4. Introductory treatment to:

- a) Pericyclic Reactions

Concerted reactions, Molecular orbitals, Symmetry properties HOMO, LUMO, Thermal and photochemical pericyclic reactions. Types of pericyclic reactions - electrocyclic, cycloaddition and sigmatropic reactions - one example each.

- b) Synthetic strategies

Terminology - Disconnection (dis), Symbol ( ), synthon, synthetic equivalent (SE), Functional group interconversion (FGI), Linear, Convergent and Combinatorial syntheses, Target molecule (TM). Retrosynthesis of the following molecules

a) acetophenone 2) cyclohexene 3) phenylethylbromide

- c) Asymmetric (Chiral) synthesis

Definitions-Asymmetric synthesis, enantiometric excess, diastereometric excess. stereospecific reaction, definition, example, dehalogenation of 1,2-dibromides by I, stereoselective reaction, definition, example, acid catalysed dehydration of 1-phenylpropanol

## LABORATORY COURSE - II

### Practical Paper - II : Inorganic Chemistry)

#### I. Titrimetric analysis :

- 1) Determination of carbonate and bicarbonate in a mixture
- 2) Determination of Fe(II) using  $K_2Cr_2O_7$
- 3) Determination of Fe(II) using  $KMnO_4$  with oxalic acid as primary standard.
- 4) Determination of Cu(II) using  $Na_2S_2O_3$  with  $K_2Cr_2O_7$  as primary standard
- 5) Determination of Zinc using EDTA
- 6) Determination of hardness of water
- 7) Determination of Zinc by ferrocyanide

#### II. Gravimetric analysis (any three of the following)

- 1) Determination of barium as barium sulphate
- 2) Determination of sulphate as barium sulphate
- 3) Determination of lead as lead chromate
- 4) Determination of nickel as Ni-DMG complex
- 5) Determination of magnesium as magnesium pyrophosphate.

# THIRD YEAR

## PAPER - III

### UNIT - I : Inorganic Chemistry - III

- I. Coordination Chemistry :** IUPAC nomenclature, bonding theories review of Werner's theory and Sidgwick's concept of coordination, Valence bond theory, geometries of coordination numbers 4-tetrahedral and square planar and 6-octahedral and its limitations, crystal field theory, splitting of d-orbitals in octahedral, tetrahedral and square-planar complexes - low spin and high spin complexes - factors affecting crystal - field splitting energy, merits and demerits of crystal-field theory. Isomerism in coordination compounds - structural isomerism and stereo isomerism, stereochemistry of complexes with 4 and 6 coordination numbers.
2. Spectral and magnetic properties of metal complexes: Electronic absorption spectrum of  $(\text{Ti}(\text{H}_2\text{O})_6)^{3+}$  ion. Types of magnetic behavior, spin-only formula, calculation of magnetic moments, experimental determination of magnetic susceptibility - Gouy method.
3. Reactivity of metal complexes: Labile and inert complexes, ligand substitution reactions -  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$ , substitution reactions of square planar complexes - Trans effect and applications of trans effect.
4. Stability of metal complexes: Thermodynamic stability and kinetic stability, factors affecting the stability of metal complexes, chelate effect, determination of composition of complex by Job's method and mole ratio method.
5. Hard and soft acids bases (HSAB) : Classification, Pearson's concept of hardness and softness, application of HSAB principles - Stability of compounds / complexes, predicting the feasibility of a reaction.
6. Bioinorganic chemistry : Essential elements, biological significance of Na, K, Mg, Ca, Fe and Chloride (Cl). Metalloporphyrins - Hemoglobin, structure and function, chlorophyll, structure and role in photosynthesis.

### UNIT - II : Organic Chemistry-III

#### 1. Nitrogen compounds

Nitro hydrocarbons : Nomenclature and classification - Nitro hydrocarbons - structure. Tautomerism of nitroalkanes leading to



acid and keto form. Preparation of Nitroalkanes. Reactivity - Halogenation, reaction with HONO (Nitrous acid), Nef reaction and Mannich reaction leading to Michael addition and reduction.

Amines (aliphatic and aromatic): Nomenclature, Classification into 1<sup>o</sup>, 2<sup>o</sup>, 3<sup>o</sup>. Amines and Quarternary ammonium compounds. Preparative methods-1. Amonolysis of alkyl halides. 2. Gabriel synthesis. 3. Hoffman's bromamide reduction reaction (mechanism). 4. Reduction of Amides and Schmidt reaction. Physical properties and basic character Comparative basic strength of Ammonia, methyl amine, dimethyl amine, trimethyl amine and aniline - comparative basic strength of aniline, N-methylaniline and N,N-dimethyl aniline (in aqueous and non-aquous medium), steric effects and substituent effects. Use of amine salts as phase transfer catalysts. Chemical properties: a) Alkylation b) Acylation c) Carbylamine reaction d) Hinsberg separation e) reaction with nitrous acid of 1<sup>o</sup>, 2<sup>o</sup>, 3<sup>o</sup> (Aliphatic and aromatic amines). Electrophilic substitutions of Aromatic amines - Bromination and Nitration oxidation of aryl and 3<sup>o</sup> amines. Diazotization Cyanides and isocyanides: Nomenclature (Aliphatic and aromatic) structure. preparation of cyanides from a) Alkyl halides b) from amides c) from aldoximes. Preparation of isocyanides from Alkyl halides and Amines. Properties of cyanides and isocyanides, a) hydrolysis b) addition of Grignard reagent ii) reduction iv) oxidation.

## 2. heterocyclic compounds

Introduction and definition: Simple 5 membered ring compounds with one hetero atom Ex. Furan. Thiophene and pyrrole. Importance of ring system - presence in important natural products like hemoglobin and chlorophyll. Numbering the ring systems as per Greek letter and Numbers. Aromatic character - 6-electron system (four-electrons from two double bonds and a pair of non-bonded electrons from the hetero atom). Tendency to undergo substitution reactions.

Resonance structures: Indicating electron surplus carbons and electron deficient heteroatom. Explanation of feebly acidic character of pyrrole, electrophilic substitution at 2 or 5 position, Halogenation, Nitration and Sulphonation under mild conditions. Reactivity of furan as 1,3-diene, Diels Alder reactions (one example). Sulphonation of thiophene purification of Benzene obtained from coal tar). Preparation of furan, Pyrrole and thiophene from 1,4-

dicarbonyl compounds only, Paul-Knorr synthesis, structure of pyridine, Basicity - Aromaticity - Comparison with pyrrole - one method of preparation and properties - Reactivity toward Nucleophilic substitution reaction - chichibabin reaction.

### 3. Carbohydrates

Monosaccharides: All discussion to be confined to (+) glucose as an example of aldo hexoses and D(-) fructose as example of ketohexoses. Chemical properties and structural elucidation: Evidences for straight chain pentahydroxy aldehyde structure (Acetylation, reduction to n-hexane, cyanohydrin formation, reduction of Tollen's and Fehling's reagents and oxidation to gluconic and saccharic acid). Number of optically active isomers possible for the structure, configuration of glucose based on D-glyceraldehyde as primary standard (no proof for configuration is required). Evidence for cyclic structure of glucose. Decomposition of cyclic structure (Pyranose structure, anomeric Carbon and anomers). Proof for the ring size (methylation, hydrolysis and oxidation reactions). Different ways of writing pyranose structure (Haworth formula and chair conformation formula). Structure of fructose: Evidence of 2-ketohexose structure (formation of penta acetate, formation of cyanohydrin its hydrolysis and reduction by HI to give --carboxy-n-hexane). Same osazone formation from glucose and fructose, Hydrogen bonding in osazones, cyclic structure of fructose (Furanose structure and Hawroth formula).

Interconversion of Monosaccharides: Aldopentose to aldo hexose- eg: Arabinose to D-Glucose, D-Mannose (Kiliani - Fischer method). Epimers, Epimerisation - Lobry de bruyn van Ekenstein rearrangement. Aldohexose to Aldopentose eg: D-glucose to D-arabinose by Ruff's degradation. Aldohexose (+) (glucose) to ketohexose (-) (Fructose) and Ketohexose (Fructose) to aldohexose (Glucose).

### 4. Amino acids and proteins

Introduction : Definition of Amino acids, classification of Amino acids into alpha, beta, and gamma amino acids. Natural and essential amino acids - definition and examples, classification of alpha amino acids into acidic, basic and neutral amino acids with examples. Methods of synthesis : General methods of synthesis of alpha amino acids (specific examples - Glycine, Alanine, Valine and Leucine)

by following methods: a) from halogenated carboxylic acid b) Malonic ester synthesis c) strecker's synthesis.

Physical properties : Optical activity of naturally occurring amino acids: L-configuration, irrespective of sign rotation, Zwitterion structure - salt like character - solubility, melting points, amphoteric character, definition of isoelectric point.

Chemical properties: General reactions due to amino and carboxyl groups - lactams from gamma and delta amino acids by heating peptide bond (amide linkage). Structure and nomenclature of peptides and proteins.

## **5. Mass Spectrometry :**

Basic principles - Molecular ion / parent ion, fragment ions / daughter ions. Theory formation of parent ions. Representation of mass spectrum. Identification of parent ion,  $(M + 1)$ ,  $(M + 2)$ , base peaks (relative abundance 100%). Mass spectra of ethylbenzene, acetophenone, n-butylamine and 1-propanol

## **UNIT - III : Physical Chemistry - III**

### **1. Chemical kinetics**

Rate of reaction, factors influencing the rate of a reaction-concentration, temperature, pressure, solvent, light, catalyst. Experimental methods to determine the rate of reaction. Definition of order and molecularity. Derivation of rate constants for first, second and zero order reactions and examples. Derivation for half life period. Methods to determine the order of reactions. Effect of temperature on rate of reaction Arrhenius equation, concept of activation energy. Theories of reaction rates-collision theory-derivation of rate constant for bimolecular reaction. The transition state theory (Elementary treatment).

### **2. Photochemistry**

Difference between thermal and photochemical processes. Laws of photochemistry-grothus-Draper's law and Stark-Einstein's law of photochemical equivalence. Quantum yield. Photochemical hydrogen-chlorine, hydrogen-bromine reaction. Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative process (internal conversion, intersystem crossing). Photosensitized reactions - energy transfer processes (simple example).

### 3. Thermodynamics

**The first law of thermodynamics :** Statement, definition of internal energy and enthalpy. Heat capacities and their relationship. Joule's law Joule-Thomson effect and coefficient. Calculation of  $w$ ,  $q$ ,  $dE$  and  $dH$  for the expansion of perfect gas under Isotherm and Adiabatic conditions for reversible processes. State function. Temperature dependence of enthalpy of formation-Kirchoff's equation.

**Second law of thermodynamics :** Different Statements of the law. Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of entropy, entropy as a state function, entropy changes in cyclic, reversible, and irreversible processes and reversible phase change. Calculation of entropy changes with changes in  $V$  &  $T$  and  $P$  &  $T$ . Entropy changes in spontaneous and equilibrium processes.

The Gibbs ( $G$ ) and Helmholtz ( $A$ ) energies.  $A$  &  $G$  as criteria for thermodynamic equilibrium and spontaneity-advantage over entropy change. Gibbs equation and Variation of  $G$  with  $P$  and  $T$ .

## PAPER - IV :

### CHEMISTRY AND INDUSTRY

#### UNIT - I : Physico Chemical Methods of analysis

##### 1. Separation Techniques

1. Chromatography : Classification of chromatography methods, principles of differential migration adsorption phenomenon, Nature of adsorbents, solvent systems,  $R_f$  values, factors effecting  $R_f$  values.
  - a) Paper chromatography : Principles,  $R_f$  Values, Experimental procedures, choice of paper and solvent systems, development of chromatogram - ascending, descending and radial. Two dimensional chromatography, applications.
  - b) Thin layer Chromatography (TLC): Advantages. Principles, factors effecting  $R_f$  values. Experiment procedures. Adsorbents and solvents. Preparation of plates. Development of the chromatogram. Detection of the spots. Applications.
  - c) Column Chromatography : Principle, experimental procedures, Stationary and mobile Phase, Separation technique. Applications.

##### 2. Spectrophotometry

General features of absorption - spectroscopy , Beer-Lambert's law and its limitations, transmittance, Absorbance, and molar absorptivity.

Double beam spectrophotometer. Application of Beer-Lambert law for quantitative analysis of

1. Chromium in  $K_2Cr_2O_7$
2. Manganese in  $KMnO_4$
3. Iron (III) with thiocyanate.

### 3. Molecular spectroscopy

#### (i) Electronic spectroscopy :

Interaction of electromagnetic radiation with molecules and types of molecular spectra. Potential energy curves for bonding and antibonding molecular orbitals. Energy levels of molecules ( $\sigma$ ,  $\pi$ ,  $\sigma^*$ ,  $\pi^*$ ). Selection rules for electronic spectra. Types of electronic transitions in molecules effect of conjugation. Concept of chromophore.

#### (ii) Infra red spectroscopy

Energy levels of simple harmonic oscillator, molecular vibration spectrum, selection rules. Determination of force constant. Qualitative relation of force constant to bond energies. Modes of vibrations in like  $CO$ ,  $CO_2$  &  $H_2O$  molecules. Characteristic absorption bands of various functional groups. Finger Print nature of infrared spectrum.

#### (iii) Proton magnetic resonance spectroscopy ( $^1H$ -NMR)

Principles of nuclear magnetic resonance, equivalent and non-equivalent protons, position of signals. Chemical shift, NMR splitting of signals - spin-spin coupling, coupling constants. Applications of NMR with suitable examples - ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromo ethane, ethyl acetate, toluene and acetophenone.

#### (iv) Spectral interpretation

Interpretation of IR, UV-Visible,  $^1H$ -NMR and mass spectral data of the following compounds 1. Phenyl acetylene 2. Acetophenone 3. Cinnamic acid 4. Para-nitro aniline.

## UNIT - II : Drugs, formulations, pesticides and green chemistry

### 1. Drugs

1. Introduction: Drug, Disease (definition), Historical evolution, Sources - Plant, Animal synthetic, Biotechnology and human gene therapy

2. Terminology: Pharmacy, Pharmacology, Pharmacophore, Pharmacodynamics, Pharmacokinetics (ADME, Receptors - brief treatment) Metabolites and anti metabolites.
3. Nomenclature: Chemical name, Generic name and trade names with examples.
4. Classification: Classification based on structures and therapeutic activity with one example each.
5. Synthesis: Synthesis and therapeutic activity of the following drugs., L-Dopa, chloroquin, Omeprazole, Albuterol and ciprofloxacin.
6. Drug Development : Pencillin, Separation and isolation, structures of different pencillins.
7. Monographs of drugs: Eg Paracetamol, Sulpha methoxazole (Tablets).

## 2. Formulations

1. Need of conversion of drugs into medicine. Additives and their role (Brief account only)
2. Different types of formulations.

## 3. Green Chemistry

**Introduction :** Definition of green Chemistry, need of green chemistry, basic principles of green chemistry.

**Green synthesis :** Evaluation of the type of the reaction i) Rearrangements (100% atom economic), (ii) Addition reaction (100% atom economic), pericyclic reactions (No by-product).

Selection of solvent :

- i) Aqueous phase reactions
- ii) reactions in ionic liquids
- iii) Solid supported synthesis
- iv) Solvent free reactions (solid phase reactions)

Microwave and Ultrasound assisted green synthesis :

- 1) Aldol condensation
- 2) Cannizzaro reaction
- 3) Diels-Alder reactions
- 4) Strecker synthesis

- 5) Willaimson synthesis
- 6) Dieckmann condensation

### **UNIT - III: (polymers, material science, and catalysis)**

#### **1. Polymers**

Classification of polymers, chemistry of polymerization, chain polymerization, step polymerization, coordination polymerization - tacticity (isotactic, syndiotactic, atactic poly propylene). Molecular weight of polymers - number average and weight average molecular weight, degree of polymerization, determination of molecular weight of polymers by viscometry, Osmometry : mechanism of free radical polymerization, Preparation and industrial application of polyethylene, PVC, Teflon, polyacrylonitrile, terylene and Nylon-66.

#### **2. Material Science :**

Properties and applications of nano-materials.

#### **3. Catalysis**

Homogeneous and heterogeneous catalysis, comparison with examples. Kinetics of specific acid catalyzed reactions, inversion of cane sugar. Kinetics of specific base catalyzed reactions base catalyzed conversion of acetone to diacetone alcohol. Acid and base catalyzed reactions hydrolysis of esters, mutarotation of glucose. Enzyme catalysis: Classification, characteristics of enzyme catalysis. Kinetics of enzyme catalyzed reactions-Michael's Menten law, significance of Michael's constant ( $K_m$ ) and maximum velocity ( $V_{max}$ ). Factors affecting enzyme catalysis effect of temperature, pH, concentration and inhibitor. Catalytic efficiency, Mechanism of oxidation of ethanol by alcohol dehydrogenase.

# LABORATORY COURSE - III

## Practical Paper - III : Organic Chemistry

### I. Synthesis of Organic Compounds

- i. Aromatic electrophilic substitution Nitration: Preparation of nitro benzene and p-nitro acetanilide, Halogenation: Preparation of p-bromo acetanilide and 2,4,6- tribromo phenol.
- ii. Diazotization and coupling: Preparation of p-phenyl azo  $\alpha$ -naphthol
- iii. Oxidation: Preparation of benzoic acid from benzyl chloride
- iv. Reduction: Preparation of m-nitro aniline from m-dinitro benzene
- v. Esterification: Preparation of methyl para nitro benzoate from p-nitro Benzoic Acid.
- vi. Methylations : Preparation of  $\alpha$ -naphthyl methyl ether
- vii. Condensation: Preparation of benzilidene aniline

### 2. Thin layer Chromatography

- i. Preparation of the TLC plates. Checking the purity of the compounds by TLC.
- ii. Separation of ortho and p-nitro aniline mixture by column chromatography.

### 3. Organic Qualitative Analysis :

- i. Identification of an organic compound through the functional group analysis. Determination of melting point and preparation of suitable derivatives.
  - i. Aniline+Naphthalene
  - ii. Benzoic acid+Benzophenone.
  - iii. p-cresol-chlorobenzene
- ii. Separation of two component mixture Benzoic acid+benzophenone

### 4. Demonstration experiments

1. Steam distillation experiment: Separation of ortho and para nitro phenols
- 2) Microwave assisted Green synthesis, two examples:
  1. Hydrolysis of Benzamide
  2. Oxidation of Toluene.



# LABORATORY COURSE - IV

## Practical Paper - IV : Physical Chemistry

### 1. Chemical Kinetics

- i. Kinetic study of Acid Catalyzed hydrolysis of methyl acetate and determination of rate constant - Graphical method.
- ii. Kinetic study of Acid catalysed Acetone - Iodine reaction and determination of rate constant - Graphical method.
- iii. Kinetic study of persulphate iodide reaction and determination rate constant - Graphical method

### 2. Distribution law

- i. Determination of distribution coefficient of iodine between water and carbon Tetrachloride.
- ii. Determination of molecular state and partition coefficient of benzoic acid in Toluene and water.

### 3. Electrochemistry

- i. Determination of concentration of HCl conductometrically using standard NaOH solution.
- ii. Determination of concentration of acetic acid conductometrically using standard NaOH solution.
- iii. Determination of solubility and solubility product of  $\text{BaSO}_4$ .
- iv. Determination of redox potentials of  $\text{Fe}^{2+}$  by potentiometric titration of ferrous ammonium sulphate vs.  $\text{KMnO}_4$ .

### 4. pH metry

- i. Preparation of phosphate buffer solutions
- ii. pH metric titration of weak acid, acetic acid with strong base NaOH and calculation of dissociation constant.

### 5. Colorimetry

- i. Verification of Beer-Lambert law for  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$  and determination of concentration of the given solution

- ii. Verification of Beer-Lambert law for  $\text{CuSO}_4$  and determination of concentration of the given solution.

## 6. Adsorption

- i. Surface tension and viscosity of liquids
- ii. Adsorption of acetic acid on animal charcoal, verification of Freundlich isotherm

## 7. Project work :

- i. Collection of spectral data of a minimum of six compounds belonging to different functional groups and submission of the report. (other than those included in the syllabus)

**Note :** Apart from the experiments (1 to 6) the project work (7) shall also be included in the University Examination.

### *Recommended Text Books and Reference Books :*

#### **Inorganic Chemistry**

1. Concise Inorganic Chemistry by J.D. Lee
2. Basic Inorganic Chemistry by Cotton and Wilkinson
3. Advanced Inorganic Chemistry Vol-I by Satyaprakash, Tuli, Basu and Madan
4. Inorganic Chemistry by R R Heslop and P.L. Robinson
5. Modern Inorganic Chemistry by C F Bell and K A K Lott
6. University Chemistry by Bruce Mohan
7. Qualitative Inorganic analysis by A.I. Vogel
8. A textbook of qualitative inorganic analysis by A.I. Vogel.
9. Inorganic Chemistry by J.E. Huheey
10. Inorganic Chemistry by Chopra and Kapoor
11. Coordination Chemistry by Basalo and Johnson
12. Organometallic Chemistry - An introduction by R.C. Mehrotra and A. Singh
13. Inorganic Chemistry by D.F. Shriver, P.W. Atkins and C.H. Langford
14. Inorganic Chemistry by Philips and Williams, Lab Manuals
15. Introduction to inorganic reactions mechanisms by A.C. Lockhart
16. Theoretical inorganic chemistry by McDay and J. Selbin
17. Chemical bonding and molecular geometry by R.J. Gillespy and P.L. Popelier

18. Advanced Inorganic Chemistry By Gurudeep Raj
19. Analytical chemistry by Gary D Christian, Wiley India.
20. Analytical Chemistry by G.L. David Krupadanam, et al, Univ. Press
21. Selected topics in inorganic chemistry by W.D. Malik, G.D. Tuli, R.D. Madan
22. Concepts and models of Inorganic Chemistry by Bodie Douglas, D. McDaniel and J. Alexander
23. Modern Inorganic Chemistry by William L. Jolly
24. Concise coordination chemistry by Gopalan and Ramalingam
25. Satyaprakash's modern inorganic chemistry by R.D. Madan

### **Organic Chemistry :**

1. Organic Chemistry By R T Morrison and R.N. Boyd
2. Organic Chemistry by T.J. Solomons
3. Organic Chemistry by L.G. Wade Sr
4. Organic Chemistry by D. Cram, G.S. Hammond and Herdricks
5. Modern Organic Chemistry by J.D. Roberts and M.C. Caserio
6. Textbook of Organic Chemistry by Ferguson
7. Problems and their solutions in organic Chemistry by I.L. Finar
8. Reaction mechanisms in Organic Chemistry by S.M. Mukherji and S.P. Singh
9. A guide book to mechanisms in Organic Chemistry by Peter Sykes
10. Organic spectroscopy by J.R. Dyer
11. Organic Spectroscopy by William Kemp
12. Fundamentals of organic synthesis and retrosynthetic analysis by Ratna Kumar kar
13. Comprehensive practical organic qualitative analysis by V.K. Ahluwalia & Sumta Dhingra
14. Comprehensive practical organic chemistry: Preparation and quantitative analysis by V.K. Ahluwalia and Reena Agarwal.
15. Organic Chemistry by Janice Gorzynski
16. Organic Chemistry by Stanley H Pine
17. Fundamentals of Organic Chemistry by John Mc Murray, Eric Simanek
18. Organic Chemistry by Francis A Carey
19. Text book of Organic Chemistry by K.S. Mukherjee
20. Organic Chemistry by Bhupinder Mehta & Manju Mehta

21. Organic Chemistry by L.G. Wade Jr, Maya Shankar Singh
22. Elementary organic spectroscopy by Y.R. Sharma
23. Chemistry & Industry by Gurdeep R. Chatwal
24. Applied Chemistry by Jayashree Ghosh
25. Drugs by David Krupadanam
26. Pharmacodynamics by R.C. Srivastava, Subit Ghosh
27. Analytical Chemistry by David Krupadanam
28. Green Chemistry - V.K. Ahluwalia
29. Organic Synthesis by V.K. Ahluwalia and R. Agarwal
30. New trends in Green Chemistry - by V.K. Ahulwalia & M. Kidwai
31. Industrial Chemistry by B.K. Sharma
32. Industrial Chemistry by Banerji
33. Industrial Chemistry by M.G. Arora
34. Industrial Chemistry by O.P. Veramani & A.K. Narula
35. Synthetic Drugs by O.D. Tyagi & M. Yadav
36. Medicinal Chemistry by Ashutoshkar
37. Medicinal Chemistry by P. Parimoo
38. Phaarmcology & Pharmacotherapeutics by R.S. Satoshkar & S.D. Bhandenkar
39. Medicinal Chemistry by Kadametal P-I & P-II
40. European Pharmacopoeia
41. Vogel's Qualitative organic analysis.
42. Laboratory manual of Organic Chemistry by Raj K Bansal

**Physical Chemistry Books :**

1. Physical chemistry A molecular approach by Donald A. Mcquarrie and John. D. Simon
2. Physical chemistry by G M Barrow
3. Principles of physical chemistry by Prutton and Marron
4. Physical chemistry by Peter Atkins, Julio D. Paula
5. Physical Chemistry by Ira N Levine
6. Elements of Physical Chemistry by Peter Atkins, Julio D. Paula
7. Text Book of Physical Chemistry by P.L. Soni, O.P. Dharmarha and Q.N. Dash
8. Solid State Chemistry and its applications by Anthony R. West

9. Text book of physical chemistry by k L Kapoor
10. Thermodynamics for Chemists by S Glasston
11. Chemical Kinetics by K J Laidler
12. An Introduction to Electrochemisty by S. Glasston
13. Physical Chemistry through problems by S.K. Dogra
14. Thermodynamics by J. Jayaram and J.C. Kuriakose
15. Introductory Quantum Chemistry by A.K. Chandra
16. Physical Chemistry by J.W. Moore
17. Kinetics and mechanism by J.W. Moore and R.G. Pearson
18. Fundamentals of photochemistry by K.K. Rohtagi Mukharjee
19. Chemical thermodynamics by R.P. Rastogi and S.S. Misra
20. Advanced physical chemistry by Gurudeep Raj
21. Physical chemistry by G.W. castellan
22. Physical chemistry by Silbey, Alberty and Bawendi.
23. Elements of physical chemistry by S. Glasstone
24. Text book of physical chemistry by S. Glasstone
25. Fundamentals of Molecular spectroscopy by C.N. Banwell and E.M. McCash
26. Nanochemistry by Geoffrey Ozin and Andre Arsenault
27. Catalysis : Concepts and green applications by Gadi Rotherberg
28. Green Chemistry: Theory and practice by P.T. Anastas and J.C. Warner
29. Polymer Science by Gowriker, Viswanathan and Jayadev Sridhar
30. Introduction Polymer Chemistry by G.S. Misra
31. Polymer Chemistry by Bilmayer
32. Kinetics and Mechanism of Chemical Transformations by Rajaram and Kuriacose.
33. Senior practical physical chemistry by Khosla

**B.Sc I Yr CHEMISTRY**  
**SEMESTER WISE SYLLABUS**  
**SEMESTER I**  
**Paper - I**  
**Chemistry - I**

**Unit-I (Inorganic Chemistry)**

**15 h (1 hr/week)**

**S1- I-1. Chemical Bonding**

8 h

Ionic solids- lattice and solvation energy, solubility of ionic solids, Fajan's rule, polarity and polarizability of ions. VSPER Theory - Common hybridization- $sp$ ,  $sp^2$ ,  $sp^3$ ,  $sp^3d$ ,  $sp^3d^2$  and  $sp^3d^3$ , shapes of molecules. Molecular orbital theory: Shapes and sign convention of atomic orbitals. Modes of bonds. Criteria for orbital overlap. LCAO concept.  $\pi$  and  $\sigma$  overlapping. Concept of Types of molecular orbitals- bonding, antibonding and non bonding. MOED of homonuclear diatomics -  $H_2$ ,  $N_2$ ,  $O_2^-$ ,  $O_2^{2-}$ ,  $F_2$  (unhybridized diagrams only) and heteronuclear diatomics  $CO$ ,  $CN^-$ ,  $NO$ ,  $NO^+$  and  $HF$ . Bond order, stability and magnetic properties.

**S1-I-2. p-Block Elements 1**

7 h

Group-13: Structure of diborane and higher Boranes ( $B_4H_{10}$  and  $B_5H_9$ ), Boron nitrogen compounds ( $B_3N_3H_6$  and  $BN$ ), Lewis acid nature of  $BX_3$ .  
Group - 14: Carbides-Classification - ionic, covalent, interstitial - Structures and reactivity. Industrial applications. Silicones - Classification - straight chain, cyclic and cross-linked.  
Group - 15: Nitrides - Classification - ionic, covalent and interstitial. Reactivity - hydrolysis. Reactions of hydrazine, hydroxyl amine, phosphazenes.

**Unit - II (Organic Chemistry)**

**15h(1 hr/week)**

**S1-O-1: Structural Theory in Organic Chemistry**

5 h

Bond polarization: Factors influencing the polarization of covalent bonds, electro negativity - inductive effect. Application of inductive effect (a) Basicity of amines (b) Acidity of carboxylic acids (c) Stability of carbonium ions. Resonance - Mesomeric effect, application to (a) acidity of phenol. (b) acidity of carboxylic acids and basicity of anilines. Stability of carbo cations, carbanions and free radicals. Hyper conjugation and its application to stability of carbonium ions, free radicals and alkenes.

**S1-O-2: Acyclic Hydrocarbons**

6 h

**Alkanes**- Methods of preparation: From Grignard reagent, Kolbe synthesis. Chemical reactivity - inert nature, free radical substitution, Halogenation example- reactivity, selectivity and orientation.

**Alkenes** - Preparation of alkenes (with mechanism) (a) by dehydration of alcohols (b) dehydrohalogenation of alkyl halides (c) by dehalogenation of 1,2 dihalides, Zaitsev's rule. Properties: Anti-addition of halogen and its mechanism. Addition of  $HX$ , Markonikov's rule, addition of  $H_2O$ ,  $HOX$ ,  $H_2SO_4$  with mechanism and addition of  $HBr$  in the presence of peroxide (anti - Markonikov's addition). Oxidation (cis - additions) - hydroxylation by  $KMnO_4$ ,  $OsO_4$ ,

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anti addition- peracids (via epoxidation), hydroboration, ozonolysis – location of double bond. Dienes – Types of dienes, reactions of conjugated dienes – 1,2 and 1,4 addition of HBr to 1,3 – butadiene and Diels – Alder reaction.

**Alkynes**– Preparation by dehydrohalogenation of vicinal dihalides, dehalogenation of tetrahalides. Physical Properties: Chemical reactivity – electrophilic addition of  $X_2$ , HX,  $H_2O$  (tautomerism), Oxidation (formation of enediol, 1,2 diones and carboxylic acids) and reduction (Metal-ammonia reduction, catalytic hydrogenation).

### Aromatic Hydrocarbons

4h

Introduction to aromaticity: Huckel's rule – Benzene, Naphthalene and Anthracene. Reactions - General mechanism of electrophilic substitution, mechanism of nitration, sulphonation and halogenation, Friedel Craft's alkylation and acylation. Orientation of aromatic substitution - Definition of ortho, para, and meta directing groups. Ring activating and deactivating groups with examples. Orientation – (i) activating groups: Amino, methoxy and alkyl groups. (ii) Deactivating groups - nitro, nitrile, carbonyl, carboxylic acid, sulphonic acid and halo groups.

### Unit – III (Physical Chemistry)

15h(1 hr/week)

#### S1-P-1: Atomic structure and elementary quantum mechanics

3 h

Black body radiation, heat capacities of solids, Rayleigh Jeans law, Planck's radiation law, photoelectric effect, Limitations of classical mechanics, Compton effect, de Broglie's hypothesis. Heisenberg's uncertainty principle.

#### S1-P-2: Gaseous State

5 h

Deviation of real gases from ideal behavior. van der Waals equation of state. Critical phenomenon. PV isotherms of real gases, continuity of state. Andrew's isotherms of  $CO_2$ . The van der Waal's equation and critical state. Derivation of relationship between critical constants and van der Waal's constants. The law of corresponding states, reduced equation of states. Joule Thomson effect and inversion temperature of a gas. Liquifaction of gases: i) Linde's method based on Joule Thomson effect ii) Claude's method based on adiabatic expansion of a gas.

#### S1-P-3: Liquid State and Solutions

4h

##### Liquid State

Intermolecular forces, structure of liquids (qualitative description). Structural differences between solids, liquids and gases. Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

##### Solutions

3h

Liquid - liquid mixtures, ideal liquid mixtures, Raoult's and Henry's laws. Non ideal systems. Azeotropes: HCl- $H_2O$  and  $C_2H_5OH - H_2O$  systems. Fractional distillation. Partially miscible liquids: Phenol – Water, Trimethyl amine – Water and Nicotine – Water systems.

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## Unit - IV (General Chemistry)

15h(1 hr/week)

### S1-G-1. General Principles of Inorganic Qualitative Analysis

6 h

Anion analysis: Theory of sodium carbonate extract, classification and reactions of anions-  $CO_3^{2-}$ ,  $Cl^-$ ,  $Br^-$ ,  $SO_4^{2-}$ ,  $PO_4^{3-}$ ,  $BO_3^{3-}$ ,  $CH_3COO^-$ ,  $NO_3^-$ . Interfering ions. Cation Analysis: Principles involved - Solubility product, common ion effect, general discussion for the separation and identification of group I individual cations ( $Hg_2^{2+}$ ,  $Ag^+$ ,  $Pb^{2+}$ ) with flow chart and chemical equations. Principle involved in separation of group II & IV cations. General discussion for the separation and identification of group II ( $Hg^{2+}$ ,  $Pb^{2+}$ ,  $Bi^{3+}$ ,  $Cd^{2+}$ ,  $Sb^{3+}$ ), III ( $Al^{3+}$ ,  $Fe^{3+}$ ), IV ( $Mn^{2+}$ ,  $Zn^{2+}$ ) individual cations with flow chart and chemical equations. General discussion for the separation and identification of group V individual cations ( $Ba^{2+}$ ,  $Sr^{2+}$ ,  $Ca^{2+}$ ) with flow chart and chemical equations. Theory of flame test. Identification of Group VI cations ( $Mg^{2+}$ ,  $NH_4^+$ ).

### S1-G-2. Isomerism

5h

**Isomerism:** Definition of isomers. Classification of isomers: Constitutional and Stereoisomers - definition and examples. Constitutional isomers: chain, functional and positional isomers. Stereoisomers: enantiomers and diastereomers - definitions and examples. Representation of stereoisomers - Wedge, Fischer projection, Sawhorse, Newmann formulae.

**Conformational analysis :** Classification of stereoisomers based on energy. Definition and examples Conformational and configurational isomers. Conformational analysis of ethane, n-butane, 1,2-dichloroethane, 2-chloroethanol. Cyclic compounds: Baeyer's strain theory, Conformational analysis of cyclohexane

Cis-trans isomerism: E-Z-Nomenclature

### S1-G-3: Solid state Chemistry

4 h

Laws of Crystallography: (i) Law of Constancy of interfacial angles (ii) Law of Symmetry-Symmetry elements in crystals (iii) Law of rationality of indices. Definition of space lattice, unit cell. Bravais Lattices and Seven Crystal systems (a brief review). X-ray diffraction by crystals; Derivation of Bragg's equation. Determination of structure of NaCl, KCl and CsCl (Bragg's method and Powder method).

## References

**General reference:** B.Sc I Year Chemistry : Semester I, Telugu Academy publication, Hyd  
Unit- I

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications 1996.
2. Concise Inorganic Chemistry by J.D. Lee 3rd edn.
3. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson and Paul.L. Gaus 3rd edn Wiley Publishers 2001. Chem.

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5. Inorganic Chemistry Principles of structure and reactivity by James E. Huhey, E.A. Keiter and R.L. Keiter 4th edn.
6. Chemistry of the elements by N.N. Greenwood and A. Earnshaw Pergamon Press 1989.
7. Inorganic Chemistry by Shriver and Atkins 3rd edn Oxford Press 1999.
9. Textbook of Inorganic Chemistry by R Gopalan.

#### Unit- II

1. Organic Chemistry by Morrison and Boyd.
2. Organic Chemistry by Graham Solomons.
3. Organic Chemistry by Bruice Yuranis Powla.
4. Organic Chemistry by L. G. Wade Jr.
5. Organic Chemistry by M. Jones, Jr
6. Organic Chemistry by John McMurry.
7. Organic Chemistry by Soni.
8. General Organic chemistry by Sachin Kumar Ghosh.
9. Organic Chemistry by C N pillai

#### Unit III

1. Principles of physical chemistry by Prutton and Marron.
2. Text Book of Physical Chemistry by Soni and Dharmahara..
3. Text Book of Physical Chemistry by Puri and Sharma.
4. Text Book of Physical Chemistry by K. L. Kapoor.
5. Physical Chemistry through problems by S.K. Dogra.
6. Text Book of Physical Chemistry by R.P. Verma.
7. Elements of Physical Chemistry by Lewis Glasstone.

#### Unit IV

1. Qualitative analysis by Welcher and Hahn.
2. Vogel's Qualitative Inorganic Analysis by Svehla.
3. Text Book of Organic Chemistry by Morrison And Boyd.
4. Text Book of Organic Chemistry by Graham Solomons.
5. Text Book of Organic Chemistry by Bruice Yuranis Powla.
6. Text Book of Organic Chemistry by Soni.
7. Text Book of Physical Chemistry by Soni And Dharmahara..
8. Text Book of Physical Chemistry by Puri And Sharma.
9. Text Book of Physical Chemistry by K. L. Kapoor.

### Laboratory Course

45h (3 h / week)

#### Paper I - Qualitative Analysis - Semi micro analysis of mixtures

Analysis of two anions (one simple, one interfering) and two cations in the given mixture.

Anions:  $CO_3^{2-}$ ,  $SO_3^{2-}$ ,  $S^{2-}$ ,  $Cl^-$ ,  $Br^-$ ,  $I^-$ ,  $CH_3COO^-$ ,  $NO_3^-$ ,  $PO_4^{3-}$ ,  $BO_3^{3-}$ ,  $SO_4^{2-}$  . .

Cations:  $Hg_2^{2+}$ ,  $Ag^+$ ,  $Pb^{2+}$

$Hg^{2+}$ ,  $Pb^{2+}$ ,  $Bi^{3+}$ ,  $Cd^{2+}$ ,  $Cu^{2+}$ ,  $As^{3+/5+}$ ,  $Sb^{3+/5+}$ ,  $Sn^{2+/4+}$

$Al^{3+}$ ,  $Cr^{3+}$ ,  $Fe^{3+}$

$Zn^{2+}$ ,  $Ni^{2+}$ ,  $Co^{2+}$ ,  $Mn^{2+}$

$Ba^{2+}$ ,  $Sr^{2+}$ ,  $Ca^{2+}$

$Mg^{2+}$ ,  $NH_4^+$

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**B.Sc I Yr CHEMISTRY**  
**SEMESTER WISE SYLLABUS**  
**SEMESTER II**  
**Paper – II**  
**Chemistry – II**

**Unit-I (Inorganic Chemistry)**

**15 h (1 hr/week)**

**S2-I-1 p-block Elements -II**

**7 h**

**Oxides:** Types of oxides (a) Normal- acidic, basic amphoteric and neutral (b) Mixed (c) sub oxide d) peroxide e) superoxide. Structure of oxides of C, N, P, S and Cl - reactivity, thermal stability, hydrolysis.

**Oxy acids:** Structure and acidic nature of oxyacids of B, C, N, P, S, Cl and I. Redox properties of oxyacids of Nitrogen:  $\text{HNO}_2$  (reaction with  $\text{FeSO}_4$ ,  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$ ),  $\text{HNO}_3$  (reaction with  $\text{H}_2\text{S}$ , Cu),  $\text{HNO}_4$  (reaction with KBr, Aniline),  $\text{H}_2\text{N}_2\text{O}_2$  (reaction with  $\text{KMnO}_4$ ). Redox properties of oxyacids of Phosphorus:  $\text{H}_3\text{PO}_2$  (reaction with  $\text{HgCl}_2$ ),  $\text{H}_3\text{PO}_3$  (reaction with  $\text{AgNO}_3$ ,  $\text{CuSO}_4$ ). Redox properties of oxyacids of Sulphur:  $\text{H}_2\text{SO}_3$  (reaction with Cu, Au),  $\text{H}_2\text{SO}_5$  (reaction with KI,  $\text{FeSO}_4$ ),  $\text{H}_2\text{S}_2\text{O}_8$  (reaction with  $\text{FeSO}_4$ , KI). Redox properties of oxy acids of Chlorine.

**Interhalogens-** Classification- general preparation- structures of AB, AB<sub>3</sub>, AB<sub>5</sub> and AB<sub>7</sub> type and reactivity.

**Poly halides-** Definition and structure of  $\text{ICl}_2^-$ ,  $\text{ICl}_4^-$  and  $\text{I}_3$ .

**Pseudohalogens:** Comparison with halogens.

**S2-I-2: Chemistry of Zero group elements**

**2 h**

Isolation of noble gases, Structure, bonding and reactivity of Xenon compounds – Oxides, Halides and Oxy-halides. Clathrate compounds and Anomalous behavior of He (II)

**S2-I-3: Chemistry of d-block elements**

**6 h**

Characteristics of d-block elements with special reference to electronic configuration, variable valence, ability to form complexes, magnetic properties & catalytic properties. Stability of various oxidation states and standard reduction potentials. Comparative treatment of second and third transition series with their 3d analogues. Study of Ti, Cr and Cu triads. Titanium triad – electronic configuration and reactivity of +3 and +4 states – oxides and halides. Chromium triad – reactivity of +3 and +6 states. Copper triad – reactivity of +1, +2 and +3 states.

**Unit - II (Organic Chemistry)**

**15h(1 hr/week)**

**S2-O-1: Halogen compounds**

**4 hrs**

Classification: alkyl (primary, secondary, tertiary), aryl, aralkyl, allyl, vinyl, benzyl. Chemical reactivity - reduction, formation of  $\text{RMgX}$ , Nucleophilic substitution reactions – classification into  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$ . Mechanism and energy profile diagrams of  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$  reactions. Stereochemistry of  $\text{S}_{\text{N}}2$  (Walden Inversion) 2-bromobutane,  $\text{S}_{\text{N}}1$  (Racemisation) 1-bromo-1-phenylpropane Structure and reactivity – Ease of hydrolysis - comparison of alkyl, vinyl, allyl, aryl, and benzyl halides.

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## Unit - IV (General Chemistry)

15h(1 hr/week)

### S1-G-1. General Principles of Inorganic Qualitative Analysis

6 h

Anion analysis: Theory of sodium carbonate extract, classification and reactions of anions-  $CO_3^{2-}$ ,  $Cl^-$ ,  $Br^-$ ,  $SO_4^{2-}$ ,  $PO_4^{3-}$ ,  $BO_3^{3-}$ ,  $CH_3COO^-$ ,  $NO_3^-$ . Interfering ions. Cation Analysis: Principles involved - Solubility product, common ion effect, general discussion for the separation and identification of group I individual cations ( $Hg_2^{2+}$ ,  $Ag^+$ ,  $Pb^{2+}$ ) with flow chart and chemical equations. Principle involved in separation of group II & IV cations. General discussion for the separation and identification of group II ( $Hg^{2+}$ ,  $Pb^{2+}$ ,  $Bi^{3+}$ ,  $Cd^{2+}$ ,  $Sb^{3+}$ ), III ( $Al^{3+}$ ,  $Fe^{3+}$ ), IV ( $Mn^{2+}$ ,  $Zn^{2+}$ ) individual cations with flow chart and chemical equations. General discussion for the separation and identification of group V individual cations ( $Ba^{2+}$ ,  $Sr^{2+}$ ,  $Ca^{2+}$ ) with flow chart and chemical equations. Theory of flame test. Identification of Group VI cations ( $Mg^{2+}$ ,  $NH_4^+$ ).

### S1-G-2. Isomerism

5h

**Isomerism:** Definition of isomers. Classification of isomers: Constitutional and Stereoisomers - definition and examples. Constitutional isomers: chain, functional and positional isomers. Stereoisomers: enantiomers and diastereomers - definitions and examples. Representation of stereoisomers - Wedge, Fischer projection, Sawhorse, Newmann formulae.

**Conformational analysis :** Classification of stereoisomers based on energy. Definition and examples Conformational and configurational isomers. Conformational analysis of ethane, n-butane, 1,2- dichloroethane, 2-chloroethanol .Cyclic compounds: Baeyer's strain theory, Conformational analysis of cyclohexane

Cis-trans isomerism: E-Z-Nomenclature

### S1-G-3: Solid state Chemistry

4 h

Laws of Crystallography: (i) Law of Constancy of interfacial angles (ii) Law of Symmetry- Symmetry elements in crystals (iii) Law of rationality of indices. Definition of space lattice, unit cell. Bravais Lattices and Seven Crystal systems (a brief review). X-ray diffraction by crystals; Derivation of Bragg's equation. Determination of structure of NaCl, KCl and CsCl (Bragg's method and Powder method).

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2. Concise Inorganic Chemistry by J.D. Lee 3rd edn.
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anti addition- peracids (via epoxidation), hydroboration, ozonolysis – location of double bond. Dienes – Types of dienes, reactions of conjugated dienes – 1,2 and 1,4 addition of HBr to 1,3 – butadiene and Diels – Alder reaction.

**Alkynes**– Preparation by dehydrohalogenation of vicinal dihalides, dehalogenation of tetrahalides. Physical Properties: Chemical reactivity – electrophilic addition of  $X_2$ , HX,  $H_2O$  (tautomerism), Oxidation (formation of enediol, 1,2 diones and carboxylic acids) and reduction (Metal-ammonia reduction, catalytic hydrogenation).

### Aromatic Hydrocarbons

4h

Introduction to aromaticity: Huckel's rule – Benzene, Naphthalene and Anthracene. Reactions - General mechanism of electrophilic substitution, mechanism of nitration, sulphonation and halogenation, Friedel Craft's alkylation and acylation. Orientation of aromatic substitution - Definition of ortho, para, and meta directing groups. Ring activating and deactivating groups with examples. Orientation – (i) activating groups: Amino, methoxy and alkyl groups. (ii) Deactivating groups - nitro, nitrile, carbonyl, carboxylic acid, sulphonic acid and halo groups.

### Unit – III (Physical Chemistry)

15h(1 hr/week)

#### S1-P-1: Atomic structure and elementary quantum mechanics

3 h

Black body radiation, heat capacities of solids, Rayleigh Jeans law, Planck's radiation law, photoelectric effect, Limitations of classical mechanics, Compton effect, de Broglie's hypothesis. Heisenberg's uncertainty principle.

#### S1-P-2: Gaseous State

5 h

Deviation of real gases from ideal behavior. van der Waals equation of state. Critical phenomenon. PV isotherms of real gases, continuity of state. Andrew's isotherms of  $CO_2$ . The van der Waal's equation and critical state. Derivation of relationship between critical constants and van der Waal's constants. The law of corresponding states, reduced equation of states. Joule Thomson effect and inversion temperature of a gas. Liquefaction of gases: i) Linde's method based on Joule Thomson effect ii) Claude's method based on adiabatic expansion of a gas.

#### S1-P-3: Liquid State and Solutions

4h

##### Liquid State

Intermolecular forces, structure of liquids (qualitative description). Structural differences between solids, liquids and gases. Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

##### Solutions

3h

Liquid - liquid mixtures, ideal liquid mixtures, Raoult's and Henry's laws. Non ideal systems. Azeotropes: HCl- $H_2O$  and  $C_2H_5OH - H_2O$  systems. Fractional distillation. Partially miscible liquids: Phenol – Water, Trimethyl amine – Water and Nicotine – Water systems.

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## S2-O-2: Hydroxy compounds and ethers

6 hrs

**Alcohols:** Preparation: 1°, 2° and 3° alcohols using Grignard reagent, Reduction of Carbonyl compounds, carboxylic acids and esters. Physical properties: H-bonding, Boiling point and Solubility. Reactions with Sodium, HX/ZnCl<sub>2</sub> (Lucas reagent), esterification, oxidation with PCC, alk. KMnO<sub>4</sub>, acidic dichromates, conc. HNO<sub>3</sub> and Oppenauer oxidation (Mechanism).

**Phenols:** Preparation: (i) from diazonium salts of anilines, (ii) from benzene sulphonic acids and (iii) Cumene hydroperoxide .

Properties: Acidic nature, formation of phenoxide and reaction with R-X, electrophilic substitution; halogenations, Reimer Tiemann reaction (Mechanism), Kolbe reaction (Mechanism), Gattermann-Koch reaction, Azo-coupling reaction, Schotten-Boumann reaction, Houben-Hoesch condensation, .

Ethers : Nomenclature, preparation by (a) Williamson's synthesis (b) from alkenes by the action of conc. H<sub>2</sub>SO<sub>4</sub>. Physical properties – Absence of Hydrogen bonding, insoluble in water, low boiling point. Chemical properties – inert nature, action of conc. H<sub>2</sub>SO<sub>4</sub> and HI.

## S2-O-3 Carbonyl compounds

5h

Preparation of aldehydes & ketones from acid chloride, 1,3-dithianes, nitriles and from carboxylic acids. Special methods of preparing aromatic aldehydes and ketones by (a) Oxidation of arenes (b) Hydrolysis of benzal halides Physical properties – absence of Hydrogen bonding. Reactivity of the carbonyl groups in aldehydes and ketones. Chemical reactivity: Addition of (a) NaHSO<sub>3</sub> (b) HCN (c) RMgX (d) NH<sub>3</sub> (e) RNH<sub>2</sub> (f) NH<sub>2</sub>OH (g) PhNHNH<sub>2</sub> (h) 2,4-DNP (Schiff bases). Addition of H<sub>2</sub>O to form hydrate , chloral hydrate (stable), addition of alcohols - hemiacetal and acetal formation. Cannizzaro reaction. Oxidation reactions – KMnO<sub>4</sub> oxidation and auto oxidation, reduction – catalytic hydrogenation, mechanism of Clemmenson's reduction, Wolf-kishner reduction, Meerwein Ponnoff Verly reduction. Reduction with LAH, NaBH<sub>4</sub>.

## Unit - III (Physical Chemistry)

15h(1 hr/week)

### S2-P-1: Electrochemistry

15 h

Electrical transport – conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of specific and equivalent conductance with dilution. Migration of ions and Kohlrausch's law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law - its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf's method for attackable electrodes. Applications of conductivity measurements: Determination of degree of dissociation, determination of K<sub>a</sub> of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

Electrolytic and Galvanic cells – reversible and irreversible cells, conventional representation of electrochemical cells. Electro motive force (EMF) of a cell and its measurement. Computation of EMF. Types of reversible electrodes- the gas electrode, metal-metal ion, metal-insoluble

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salt and redox electrodes. Electrode reactions, Nernst equation, cell EMF and Single electrode potential, Standard Hydrogen electrode – reference electrodes (calomel electrode) – standard electrode potential, sign conventions, electrochemical series and its significance. Applications of EMF measurements. Calculation of thermodynamic quantities of cell reactions (Gibbs free energy  $G$ , Helmholtz free energy and Equilibrium constant  $K$ ). Determination of pH using hydrogen electrode, glass electrode and quinhydrone electrode. Solubility product of AgCl. Potentiometric titrations.

## Unit – IV (General Chemistry)

15 h (1 hr/week)

### S2-G-1: Theory of Quantitative Analysis

6 hours

**Volumetric Analysis:** Introduction, standard solutions, indicators, end point, titration curves, Types of titrations: i) neutralization titration- principle, theory of acid base indicators, titration curves and selection of indicators- strong acid - strong base, strong acid –weak base, weak acid-strong base and weak acid –weak base. Theory of redox titrations - internal(KMnO<sub>4</sub>) and external indicators – use of diphenylamine and ferroin indicators. Theory of complexometric titrations – use of EBT, Murexide and Fast sulphone black indicators. Role of pH in complexometric titrations. Precipitation titrations – theory of adsorption indicators.

**Gravimetric analysis-** Introduction, nucleation, precipitation, growth of precipitate, filtration and washing, drying and incineration of precipitate, coprecipitation and post precipitation. Determination of Ni<sup>2+</sup>

### S2-G-2: Stereoisomerism

5h

**Optical activity:** Definition, wave nature of light, plane polarised light, optical rotation and specific rotation, chiral centers. Chiral molecules: definition and criteria - absence of plane, center and S<sub>n</sub> axis of symmetry – asymmetric and dissymmetric molecules. Examples of asymmetric molecules (Glyceraldehyde, Lactic acid, Alanine) and dissymmetric molecules (trans-1,2-dichlorocyclopropane). Molecules with constitutionally symmetrical chiral carbons (Tartaric acid) Molecules with constitutionally unsymmetrical chiral carbons (2,3dibromopentane). D, L configuration – examples. R, S – configuration: Cahn-Ingold-Prelog rules, examples for asymmetric and dissymmetric molecules.

### S2-G-3: Dilute Solutions & Colligative Properties

4 h

Dilute Solutions, Colligative Properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis - laws of osmotic pressure, its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point. Derivation of relation between molecular weight and elevation in boiling point and depression in freezing point.

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## References

**General reference:** B.Sc I Year Chemistry : Semester II, Telugu Academy publication, Hyd

### Unit I

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications 1996.
2. Concise Inorganic Chemistry by J.D. Lee 3<sup>rd</sup> edn.
3. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and Paul.L. Gaus 3<sup>rd</sup> edn Wiley Publishers 2001.
4. Chemistry of the elements by N.N. Greenwood and A. Earnshaw Pergamon Press 1989.
5. Inorganic Chemistry by Shriver and Atkins 3<sup>rd</sup> edn Oxford Press 1999.
6. Inorganic Chemistry Principles of structure and reactivity by James E. Huhey, E.A. Keiter and R.L. Keiter 4<sup>th</sup> Edn.
7. Textbook of inorganic chemistry by R Gopalan.

### Unit II

1. Organic Chemistry by Morrison and Boyd.
2. Organic Chemistry by Graham Solomons.
3. Organic Chemistry by Bruce Yuranis Powla.
4. Organic Chemistry by L. G. Wade Jr.
5. Organic Chemistry by M. Jones, Jr
6. Organic Chemistry by John McMurry.
7. Organic Chemistry by Soni.
8. General Organic chemistry by Sachin Kumar Ghosh.
9. Organic Chemistry by C N pillai

### Unit III

1. Physical chemistry by P W Atkins
2. Principles of physical chemistry by Prutton and Marron.
3. Text Book of Physical Chemistry by Soni and Dharmahara.
4. Text Book of Physical Chemistry by Puri and Sharma
5. Text Book of Physical Chemistry by K. L. Kapoor
6. Physical Chemistry through problems by S.K. Dogra.
7. Elements of Physical Chemistry by Lewis and Glasstone.
8. Material science by Kakani & Kakani

### Unit IV

1. Vogel's Text Book of Quantitative Analysis by G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney 5<sup>th</sup> edn Addison Wesley Longman Inc. 1999.
2. Quantitative Analysis by Day and Underwood Prentice Hall (India) VI Edn..
3. Nano: The Essentials by T. Pradeep, McGraw-Hill Education.
4. Chemistry of nanomaterials: Synthesis, Properties and applications by CNR Rao et.al.
5. Nanostructured Materials and Nanotechnology, edited by Hari Singh Nalwa, Academic Press
6. Practical chemistry by V K Ahluwalia, Sunitha Dhingra and Adarsh Gulati.

## Laboratory Course

45hrs (3 h / week)

### Paper II- Quantitative Analysis

#### Acid - Base titrations

1. Estimation of Carbonate in Washing Soda.
2. Estimation of Bicarbonate in Baking Soda.
3. Estimation of Carbonate and Bicarbonate in the Mixture.

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**KAKATIYA UNIVERSITY - WARANGAL - TELANGANA**  
Under Graduate Courses (Under CBCS 2019–2022)  
**B.Sc. CHEMISTRY II Year**  
**SEMESTER – III**

Paper-III  
Chemistry - III

**Unit-I (Inorganic Chemistry)**

**15 h (1 hr/week)**

**S3-I-1: Chemistry of f-block elements:**

**5 h**

Chemistry of Lanthanides: Position in periodic table, Electronic structure, oxidation state, ionic and atomic radii- lanthanide contraction- cause and consequences, anomalous behavior of post lanthanides-complexation- type of donor ligands preferred. Magnetic properties- paramagnetism. Colour and spectra, f-f transitions –occurrence and separation– ion exchange method, solvent extraction.

Chemistry of actinides- general features – electronic configuration, oxidation state, actinide contraction, colour and complex formation. Comparison with lanthanides.

**S3-I-2: Coordination Compounds-I**

**6 h**

Simple inorganic molecules and coordination complexes. Nomenclature – IUPAC rules, 1. Coordination number, coordination geometries of metal ions, types of ligands. 2. Brief review of Werner's theory, Sidgwick's electronic interpretation and EAN rule and their limitations. (Valence bond theory (VBT) – postulates and application to (a) tetrahedral complexes  $[\text{Ni}(\text{NH}_3)_4]^{2+}$ ,  $[\text{NiCl}_4]^{2-}$  and  $[\text{Ni}(\text{CO})_4]$  (b) Square planar complexes  $[\text{Ni}(\text{CN})_4]^{2-}$ ,  $[\text{Cu}(\text{NH}_3)_4]^{2+}$ ,  $[\text{PtCl}_4]^{2-}$  (c) Octahedral complexes  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$ ,  $[\text{FeF}_6]^{4-}$ ,  $[\text{Co}(\text{NH}_3)_6]^{3+}$ ,  $[\text{CoF}_6]^{3-}$ . Limitations of VBT. 3. Isomerism in coordination compounds, stereo isomerism – (a) geometrical isomerism in (i) square planar meta l complexes of the type  $[\text{MA}_2\text{B}_2]$ ,  $[\text{MA}_2\text{BC}]$ ,  $[\text{M}(\text{AB})_2]$ ,  $[\text{MABCD}]$ . (ii) Octahedral metal complexes of the type  $[\text{MA}_4\text{B}_2]$ ,  $[\text{M}(\text{AA})_2\text{B}_2]$ ,  $[\text{MA}_3\text{B}_3]$  using suitable examples, (b) Optical isomerism in (i). tetrahedral complexes  $[\text{MABCD}]$ , (ii). Octahedral complexes  $[\text{M}(\text{AA})_2\text{B}_2]$ ,  $[\text{M}(\text{AA})_3]$  using suitable examples. Structural isomerism: ionization, linkage, coordination ligand isomerism using suitable examples.

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**S3-I-3: Metal carbonyls and Organometallic Chemistry****4 h**

Metal carbonyls: Preparation and properties of  $\text{Ni}(\text{CO})_4$ . Structural features of  $\text{Ni}(\text{CO})_4$ ,  $\text{Fe}(\text{CO})_5$ ,  $\text{Fe}_2(\text{CO})_9$ ,  $\text{Fe}_3(\text{CO})_{12}$  and  $\text{Cr}(\text{CO})_6$  - 18 valence electron rule.

Definition, nomenclature and classification of organometallic compounds. Methods of preparation, properties and applications of alkyl and aryl compounds of Li, Mg & Al.

**Unit - II (Organic Chemistry)****15h(1 hr/week)****S3-O-1: Carboxylic acids and derivatives****5 h**

Preparation: a) Hydrolysis of Nitriles, amides and esters. b) Carbonation of Grignard reagents. Special methods of preparation of Aromatic Acids - Oxidation of Arenes. Physical properties- hydrogen bonding, dimeric association,. Chemical properties – Reactions involving H, OH and COOH groups -salt formation, anhydride formation, Acid halide formation, Esterification (mechanism) & Amide formation. Reduction of acid to the corresponding primary alcohol - via ester or acid chloride. Degradation of carboxylic acids by Huns Diecker reaction, Schmidt reaction (Decarboxylation). Arndt – Eistert synthesis, Halogenation by Hell – Volhard - Zelensky reaction. Carboxylic acid Derivatives – Hydrolysis and Amonolysis of acid halides, Acid anhydrides and esters (mechanism of ester hydrolysis by base and acid). Hydrolysis and dehydration of amides.

**S3-O-2: Nitrohydrocarbons****3 h**

Preparation of Nitroalkanes. Reactivity - halogenation, reaction with  $\text{HNO}_2$  (Nitrous acid), Nef reaction, reduction. Aromatic Nitrohydrocarbons: Preparation of Nitrobenzene by Nitration. Physical properties, chemical reactivity –Reduction of Nitrobenzenes in different media.

**S3-O-3: Amines, Cyanides and Isocyanides****7 h**

Amines: classification into  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  Amines and Quarternary ammonium compounds. Preparative methods – Ammonolysis of alkyl halides, Gabriel synthesis, Hoffman's bromamide reaction (mechanism). Reduction of Amides and Schmidt reaction. Physical properties. Use of amine salts as phase transfer catalysts. Chemical Properties: a) Alkylation b) Acylation c) Carbylamine reaction d) Hinsberg separation. Reaction with Nitrous acid of  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  (Aliphatic and aromatic amines). Electrophilic substitutions of Aromatic amines – Bromination and Nitration, oxidation of aryl and  $3^\circ$  Amines, diazotisation. Diazonium salts: Preparation with mechanism. Synthetic importance – a) Replacement of diazonium group by – OH, X (Cl)- Sandmeyer and Gatterman reaction, by fluorine (Schiemann's reaction), by iodine, CN,  $\text{NO}_2$ , H and aryl groups. Coupling Reaction of diazonium salts. i) with phenols ii) with anilines. Reduction to phenyl hydrazines.

**Cyanides and isocyanides:** Structure. Preparation of cyanides from a) Alkyl halides b) from amides c) from aldoximes. Preparation of isocyanides from Alkyl halides and Amines. Properties of cyanides and isocyanides, a) hydrolysis b) addition of Grignard reagent iii)

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reduction iv) oxidation.

### Unit III (Physical Chemistry)

15 h (1 hr/week)

#### S3-P-1: Thermodynamics -I

10 h

A brief review of - Energy, work and heat units, mechanical equivalent of heat, definition of system, surroundings. First law of thermodynamics statement- various forms mathematical expression. Thermodynamic quantities- extensive properties and intensive properties, state function and path functions. Energy as a state function and exact differential. Work of expansion and heat absorbed as path function.

Expression for work of expansion, sign convention problems on first law. Heat changes at constant pressure and heat changes at constant volume. Enthalpy. Heat capacities at constant pressure and constant volume. Derivation of  $C_p - C_v = R$ . Isothermal adiabatic processes. Reversible and irreversible processes. Reversible change and maximum work. Derivation of expression for maximum work for isothermal reversible process. Problems. Internal energy of an ideal gas. Joules experiment. Joule-Thompson coefficient. Adiabatic changes in ideal gas, derivation of equation,  $PV^\gamma = \text{constant}$ . P-V curves for isothermal and adiabatic processes. Heat of a reaction at constant volume and at constant pressure, relation between  $\Delta H$  and  $\Delta V$ .

Variation of heat of reaction with temperature. Kirchhoff's equation and problems. Limitations of first law and need for second law. Statement of second law of thermodynamics. Cyclic process. Heat engine, Carnot's theorem, Carnot's cycle. Derivation of efficiency of heat engine. Problems. Thermodynamic scale of temperature.

#### S3-P-2: Thermodynamics-II

5 h

Entropy: Definition from Carnot's cycle. Entropy as a state function. Entropy as a measure of disorder. Sign of entropy change for spontaneous and non-spontaneous processes & equilibrium processes. Entropy changes in i). Reversible isothermal process, ii). Reversible adiabatic process, iii). Phase change, iv). Reversible change of state of an ideal gas. Problems. Entropy of mixing of ideal gases. Free energy Gibbs function (G) and Helmholtz's function (A) as thermodynamic quantities. Concept of maximum work and maximum  $\Delta G$  as Criteria for spontaneity. Derivation of equation  $\Delta G = \Delta H - T\Delta S$ . Significance of the equation. Gibbs equations and Maxwell relations. Variation of G with P, V and T.

### Unit - IV (General Chemistry)

15 h (1 hr/week)

#### S3-G-1 Evaluation of analytical data

4 h

Significant figures, accuracy and precision. Errors-classification of errors- determinate and indeterminate errors, absolute and relative errors. Problems based on mean, median, range, standard deviation

#### S3-G-2: Carbanions-I

5 h

Introduction, acidic nature of  $\alpha$ -hydrogens and tautomerism in carbonyl compounds, nitro hydrocarbons, ethyl acetoacetate, diethyl malonate. Terminal alkynes. Stability of carbanions Reactions : Aldol reaction, Perkin reaction, Benzoin condensation, haloform reaction, conversion of smaller alkynes to higher alkynes.

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### S3-G-3: Phase Rule

6 h

Statement and meaning of the terms – Phase, Component and Degrees of freedom, Gibb's Phase rule, phase equilibria of one component system – water system. Phase equilibria of two-component system – Solid-Liquid equilibria, simple eutectic –Pb-Ag system, desilverisation of lead. Solid solutions – compound with congruent melting point – Mg-Zn system and incongruent melting point – NaCl-H<sub>2</sub>O system.

### References

**General reference:** B.Sc II Year Chemistry : Semester III, Telugu Academy publication, Hyd  
**Unit- I**

1. Analytical chemistry by G. L. David Krupadanam, D. Vijaya Prasad, K. Varaprasada Rao, K.L.N. Reddy and C. Sudhakar
2. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications(1996).
3. Concise Inorganic Chemistry by J.D. Lee 3<sup>rd</sup> edn Van Nostrand Reinhold Company(1977)
4. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson and Paul.L. Gaus 3<sup>rd</sup> edn Wiley Publishers (2001).
5. Inorganic Chemistry Principles of structure and reactivity by James E.Huhey, E.A. Keiter and R.L. Keiter 4<sup>th</sup> edn. (2006)
6. Chemistry of the elements by N.N.Greenwood and A. Earnshaw Pergamon Press(1989).
7. Inorganic Chemistry by Shriver and Atkins 3<sup>rd</sup> edn Oxford Press (1999).
8. Textbook of Inorganic Chemistry by R Gopalan(Universities Press(2012)
9. College Practical chemistry by V K Ahluwalia, Sunitha Dhingra and Adarsh Gulati Universities Press (India) Limited(2012)

### Unit- II

1. Text book of organic chemistry by Soni. Sultan Chand & Sons; Twenty Ninth edition (2012)
2. General Organic chemistry by Sachin Kumar Ghosh. New Age Publishers Pvt Ltd (2008).
3. Text book of organic chemistry by Morrison and Boyd. Person(2009)
4. Text book of organic chemistry by Graham Solomons. Wiley(2015)
5. Text book of organic chemistry by Bruice Yuranis Powla. (2012)
6. Text book of organic chemistry by C N pillai CRC Press (2012)
7. Organic Chemistry by L. G. Wade Jr.
8. Organic Chemistry by M. Jones, Jr
9. Organic Chemistry by John McMurry.

### Unit III

1. Principles of physical chemistry by Prutton and Marron. The MacmillanCompany; 4<sup>th</sup> Edn.(1970)
2. Text Book of Physical Chemistry by Soni and Dharmahara. Sulthan Chand and Sons.(2011)
3. Text Book of Physical Chemistry by Puri and Sharma. S. Nagin chand and Co.(2017)
4. Text Book of Physical Chemistry by K. L. Kapoor. (2012)
5. Colloidal and surface chemistry , M. Satake, Y. Hayashi, Y.Mido, S.A.Iqbal and M.S.sethi, Discovery Publishing Pvt.Ltd (2014)
7. Material science by Kakani & Kakani, New Age International(2016)
8. Physical Chemistry by Ira Levine (Author) McGraw-Hill Education; 6 edition (May 9, 2008)

### Unit IV

1. Text book of organic chemistry by Morrison and Boyd, Person(2009)

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2. Text book of organic chemistry by Graham solomons, Wiley(2015)
3. Text book of organic chemistry by Sony, Sultan Chand & Sons; 29<sup>th</sup> edition (2012)
4. Text book of organic chemistry by Bruice yuranis Powla, (2012)
5. General Organic chemistry by Sachin kumar Ghosh, New Age Publishers Pvt Ltd (2008)

### Laboratory Course

#### Paper III (Organic Synthesis)

45 h (3h/week)

#### 1. Synthesis of Organic compounds:

Acetylation: Acetylation of salicylic acid, Benzoylation of Aniline.

Aromatic electrophilic substitution: Nitration: Preparation of nitro benzene and m-dinitro benzene.

Halogenation: Preparation of p-bromo acetanilide, Preparation of 2,4,6-tribromo phenol

Oxidation: Preparation of benzoic acid from benzyl chloride.

Esterification: Preparation of n-butyl acetate from acetic acid.

Methylation: Preparation of - naphthyl methyl ether.

Condensation: Preparation of benzilidene aniline and Benzaldehyde and aniline.

Diazotisation: Azocoupling of  $\beta$ -Naphthol.

#### 2. Microwave assisted synthesis of Asprin – DEMO (demonstration only)

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**B.Sc. II yr CHEMISTRY**  
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**SEMESTER IV**  
**Paper-IV**  
**Chemistry - IV**

**Unit-I (Inorganic Chemistry) 15h (1 h/week)**  
**S4-I-1: Coordination Compounds –II 11 h**

Crystal field theory (CFT)- Postulates of CFT, splitting patterns of d-orbitals in octahedral, tetrahedral, square planar with suitable examples. Crystalfield stabilization energies and its calculations for various dn configurations in octahedral complexes. High Spin Low Spin complexes. Colour and Magnetic properties of transition metal complexes. Calculations of magnetic moments spin only formula. Detection of complex formation - basic principles of various methods- change in chemical properties, solubility, colour, pH, conductivity, magnetic susceptibility.

Hard and soft acids bases (HSAB) - Classification, Pearson's concept of hardness and softness, application of HSAB principles – Stability of compounds / complexes, predicting the feasibility of reaction. Thermodynamic and kinetic stability of transition of metal complexes. Stability of metal complexes –stepwise and overall stability constant and their relationship and chelate effect determination of composition of complex by Job's method and mole ratio method.

Applications of coordination compounds: Applications of coordination compounds a) in quantitative and qualitative analysis with suitable examples b) in medicine for removal of toxic metal ions and cancer therapy c) in industry as catalysts polymerization – Ziegler Natta catalyst d) water softening.

**S4-I-2: Bioinorganic Chemistry 4 h**

Essential elements, biological significance of Na, K, Mg, Ca, Fe, Co, Ni, Cu, Zn and chloride (Cl<sup>-</sup>). Toxic metal ions As, Hg & Pb Oxygen transport and storage – structure of hemoglobin, binding and transport of oxygen. Fixation of CO<sub>2</sub> in photosynthesis- overview of light and dark reactions in photosynthesis. Structure of chlorophyll and coordination of magnesium. Electron transport in light reactions from water to NADP<sup>+</sup> (Z – scheme).

**Semester-IV**

**Unit - II (Organic Chemistry) 15h(1 hr/week)**  
**S4-O-1: Carbohydrates 6 h**

Introduction: Classification and nomenclature. Monosaccharides: All discussion to be confined to (+) glucose as an example of aldo hexoses and (-) fructose as example of ketohexoses. Chemical properties and structural elucidation: Evidences for straight chain pentahydroxy aldehyde structure. Number of optically active, isomers possible for the structure, configuration

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of glucose based on D-glyceraldehyde as primary standard (No proof for configuration is required). Evidence for cyclic structure of glucose (Pyranose structure, anomeric Carbon and anomers). Proof for the ring size (methylation, hydrolysis and oxidation reactions). (Haworth formula and chair conformational formula). Structure of fructose: Evidence of 2 - ketohexose structure. Same osazone formation from glucose and fructose, Hydrogen bonding in osazones, cyclic structure for fructose (Furanose structure, Haworth formula).

Inter Conversion of Monosaccharides: : Arabinose to D-glucose, D- mannose (kiliani - Fischer method). Epimers, Epimerisation- Lobry de bruyn van Ekenstein rearrangement. D-glucose to D-arabinose by Ruff's degradation. Aldohexose(+) (glucose) to ketohexose (-) (fructose) and Ketohexose(Fructose) to aldohexose (Glucose).

#### S4-O-2: Amino acids and proteins

5 h

Classification. Methods of synthesis: General methods of synthesis of alpha amino acids (specific examples - Glycine, Alanine, Valine and Leucine) by following methods: a) From halogenated Carboxylic acid b) Malonic ester synthesis c) strecker's synthesis. Physical properties: Optical activity of naturally occurring amino acids. Zwitter ion structure - salt like character, definition of isoelectric point. Chemical properties: General reactions due to amino and carboxyl groups - Lactams from gamma and delta amino acids by heating peptide bond (amide linkage). Structure and nomenclature of peptides. Primary structure of proteins, di peptide synthesis

#### S4-O-3: Heterocyclic Compounds

4 h

Introduction and definition: 5 membered ring compounds with one hetero atom Ex. Furan. Thiophene and pyrrole. Importance of ring systems - Numbering. Aromatic character

Resonance structures: Explanation of feebly acidic character of pyrrole, electrophilic substitution, Halogenation, Nitration and Sulphonation. Reactivity of furan as 1,3-diene, Diels Alder reactions (one example). Sulphonation of thiophene purification of Benzene obtained from coal tar). Preparation of furan, Pyrrole and thiophene Paul-Knorr synthesis. Structure of pyridine, Basicity - Aromaticity - Comparison with pyrrole - preparation by Hantsch method and properties - Reactivity towards Nucleophilic substitution reaction - chichibabin reaction.

### Unit III (Physical Chemistry)

15h (1 hr/week)

#### S4-P-1: Chemical Kinetics

11 h

Introduction to chemical kinetics, rate of reaction, variation of concentration with time, rate laws and rate constant. Specific reaction rate. Factors influencing reaction rates: effect of concentration of reactants, effect of temperature, effect of pressure, effect of reaction medium, effect of radiation, effect of catalyst with simple examples. Order of a reaction.

First order reaction, derivation of equation for rate constant. Characteristics of first order reaction. Units for rate constant. Half- life period, graph of first order reaction, Examples- Decomposition of  $H_2O_2$  and decomposition of oxalic acid, Problems.

Pseudo first order reaction, Hydrolysis of methyl acetate, inversion of cane sugar, problems. Second order reaction, derivation of expression for second order rate constant, examples-

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Saponification of ester,  $2O_3 \rightarrow 3O_2$ ,  $C_2H_4 + H_2 \rightarrow C_2H_6$ . Characteristics of second order reaction, units for rate constants, half- life period and second order plots. Problems

#### S4-P-2: Photochemistry

4 h

Introduction to photochemical reactions, Difference between thermal and photochemical reactions, Laws of photo chemistry- Grotthus Draper law, Stark-Einstein's Law of photochemical equivalence. Quantum yield. Examples of photo chemical reactions with different quantum yields. Photo chemical combinations of  $H_2-Cl_2$  and  $H_2-Br_2$  reactions, reasons for the high and low quantum yield. Problems based on quantum efficiency. Consequences of light absorption. Singlet and triplet states. Jablonski diagram. Explanation of internal conversion, inter- system crossing, phosphorescence, fluorescence.

### Unit III (General Chemistry)

15h (1 hr/week)

#### S4-G-1: Theories of bonding in metals

4 h

Valence bond theory, Explanation of metallic properties and its limitations, Free electron theory, thermal and electrical conductivity of metals, limitations, Band theory, formation of bands, explanation of conductors, semiconductors n-type and p-type, extrinsic & intrinsic semiconductors, and insulators.

#### S4-G-2: Carbanions-II

5 h

Mannich reaction , Michael addition and Knoevenagel condensation Synthetic applications of Aceto acetic ester. Acid hydrolysis and ketonic hydrolysis: Preparation of ketones, monocarboxylic acids and dicarboxylic acids Malonic ester- synthetic applications. Preparation of (i) substituted mono carboxylic acids and (ii) substituted dicarboxylic acids.

#### S4-G-3: Colloids & Surface Chemistry

6 h

Definition of colloids. Classification of colloids. Solids in liquids (sols): preparations and properties - Kinetic, Optical and Electrical stability of colloids. Protective action. Hardy-Schultz law, Gold number. Liquids in liquids (emulsions): Types of emulsions, preparation and emulsifier. Liquids in solids(gels): Classification, preparations and properties, General applications of colloids.

**Adsorption:**Types of adsorption. Factors influencing adsorption. Freundlich adsorption isotherm. Langmuir theory of unilayer adsorption isotherm. Applications.

### References

**General reference:** B.Sc II Year Chemistry : Semester IV, Telugu Academy publication, Hyd

#### Unit- I

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications (1996).
2. Concise Inorganic Chemistry by J.D. Lee 3<sup>rd</sup> edn. Van Nostrand Reinhold Company(1977)
3. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson and Paul.L. Gaus 3<sup>rd</sup> edn Wiley Publishers (2001).
4. Inorganic Chemistry Principles of structure and reactivity by James E.Huhey, E.A. Keiter and R.L. Keiter 4<sup>th</sup> edn. (2006)
5. Chemistry of the elements by N.N.Greenwood and A. Earnshaw Pergamon Press(1989).
6. Inorganic Chemistry by Shriver and Atkins 3<sup>rd</sup> edn Oxford Press (1999).
7. Textbook of Inorganic Chemistry by R Gopalan, Universities Press,(2012)

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## Unit- II

1. Text book of organic chemistry by Soni. Sultan Chand & Sons; Twenty Ninth edition (2012)
2. General Organic chemistry by Sachin Kumar Ghosh. New Age Publishers Pvt Ltd (2008)
3. Text book of organic chemistry by Morrison and Boyd. Person (2009)
4. Text book of organic chemistry by Graham Solomons. Wiley (2015)
5. Text book of organic chemistry by Bruice Yuranis Powla. (2012)
6. Text book of organic chemistry by C N Pillai CRC Press (2012)
8. Organic Chemistry by L. G. Wade Jr.
9. Organic Chemistry by M. Jones, Jr
10. Organic Chemistry by John McMurry.

## Unit III

1. Principles of physical chemistry by Prutton and Marron. The Macmillan Company; 4<sup>th</sup> edn. (1970)
2. Text Book of Physical Chemistry by Soni and Dharmahara. Sulthan Chand & sons. (2011)
3. Text Book of Physical Chemistry by Puri and Sharma. S. Nagin chand and Co. (2017)
4. Text Book of Physical Chemistry by K. L. Kapoor. (2012)
5. Physical Chemistry through problems by S.K. Dogra. (2015)
6. Text Book of Physical Chemistry by R.P. Verma.
7. Elements of Physical Chemistry by Lewis Glasstone. Macmillan (1966)
8. Industrial Electrochemistry, D. Pletcher, Chapman & Hall, London, 1990

## Unit IV

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications (1996).
2. Concise Inorganic Chemistry by J.D. Lee 3<sup>rd</sup> edn. Van Nostrand Reinhold Company (1977)
3. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and Paul. L. Gaus 3<sup>rd</sup> edn Wiley Publishers (2001).
4. Inorganic Chemistry Principles of structure and reactivity by James E. Huhey, E.A. Keiter and R.L. Keiter 4<sup>th</sup> edn. (2006)
5. Text book of organic chemistry by Morrison and Boyd, Person (2009)
6. Text book of organic chemistry by Graham solomons, Wiley (2015)
7. Fundamentals of organic synthesis and retrosynthetic analysis by Ratna Kumar Kar, CBA, (2014)
8. Organic synthesis by Dr. Jagadamba Singh and Dr. L.D.S. Yadav, Pragati Prakashan, 2010
7. Stereochemistry of organic compounds by D. Nasipuri, New Academic Science Limited, 2012
8. Organic chemistry by Clayden, Greeves, Warren and Wothers, Oxford University Press, 2001
9. Fundamentals of Asymmetric Synthesis by G. L. David Krupadanam, Universities, Press 2014

## Laboratory Course

### Paper IV-

#### Qualitative Analysis of Organic Compounds:

45hrs (3 h/week)

Qualitative analysis: Identification of organic compounds through the functional group analysis - ignition test, determination of melting points/boiling points, solubility test, functional group tests and preparation of suitable derivatives of the following: Carboxylic acids, phenols, amines, urea, thiourea, carbohydrates, aldehydes, ketones, amides, nitro hydrocarbons, ester and naphthalene.

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**B.Sc., III YEAR CHEMISTRY**

**SEMESTER-V**

**DSE-A: Chemistry Paper-V**

***(Spectroscopy & Chromatography)***

**(04 credits)**

**60 Hrs (04 Hrs/week)**

**UNIT-I: Molecular Spectroscopy (15 Hrs)**

**S5-A-E-I:** Introduction to electromagnetic radiation, interaction of electromagnetic radiations with molecules, various types of molecular spectra.

**Rotational spectroscopy (Microwave spectroscopy)**

Rotational axis, moment of inertia, classification of molecules (based on moment of inertia), rotational energies, selection rules, determination of bond length of rigid diatomic molecules eg. HCl.

**Infra red spectroscopy**

Energy levels of simple harmonic oscillator, molecular vibration spectrum, selection rules. Determination of force constant (Problems). Qualitative relation of force constant to bond energies. Anharmonic motion of real molecules and energy levels. Modes of vibrations in polyatomic molecules. Characteristic absorption bands of various functional groups. Finger print nature of infrared spectrum

**Electronic spectroscopy**

Bonding and anti-bonding molecular orbitals, electronic energy levels of molecules ( $\sigma$ ,  $\pi$ ,  $n$ ), types of electronic transitions:  $\sigma$ - $\sigma^*$ ,  $n$ - $\sigma^*$ ,  $n$ - $\pi^*$ ,  $\pi$ - $\pi^*$  with suitable examples. Selection rules, Terminology of chromophore, auxochrome, bathochromic and hypsochromic shifts. Absorption characteristics of chromophones: diene, enone and aromatic chromophores. Representation of UV-Visible spectra. General features of absorption-spectroscopy transmittance, absorbance, and molar absorptivity. Beer-Lambert's law and its limitations.

**UNIT-II: NMR & Mass Spectroscopy (15 Hrs)**

**S5-A-E-II: Proton Magnetic Resonance Spectroscopy**

Principles of nuclear magnetic resonance, equivalent and non-equivalent protons, position of signals. Chemical shift, factors affecting chemical shifts, NMR splitting of signals – spin-spin coupling, representation of proton NMR spectrum – Integrations.  $^1\text{H}$  NMR spectrum of – ethyl bromide, acetaldehyde, 1, 1, 2- tribromo ethane, ethyl acetate and acetophenone.

**Mass Spectrometry**

Electron Impact Mass: Basic principles, Nitrogen rule, types of ions: Molecular ion, fragment ion and isotopic ions, representation of mass spectrum, types of peaks (molecular ion, fragment and isotopic ion peaks). Determination of molecular formula. Mass spectrum of ethyl chloride, ethyl bromide and acetophenone.

**UNIT-III: Separation techniques-I (15 Hrs)**

**S5-A-E-III: Solvent Extraction-** Principle, Methods of extraction: Batch extraction, continuous extraction and counter current extraction. Application– Determination of Iron (III).

**Chromatography:** Classification of chromatographic methods, principles of differential migration, adsorption phenomenon, nature of adsorbents, solvent systems.

**Thin layer Chromatography (TLC):** Advantages, preparation of plates, solid phase and mobile phase used in TLC, eluotropic series, development of the chromatogram, Detection of the spots, factors effecting  $R_f$  values and applications of TLC.

**Paper Chromatography:** Principle, choice of paper and solvent systems, development of chromatogram – ascending, descending, radial and two dimensional chromatography, detection of spots, and applications of paper chromatography.

#### **UNIT-IV: Separation techniques-II (15 Hrs)**

**S5-A-E-IV: Column Chromatography-** Principle, Types of stationary phases, Column packing – Wet packing technique, Dry packing technique. Selection criteria of mobile phase solvents for eluting polar, non-polar compounds and its applications.

**Ion exchange chromatography:** Principle, cation and anion exchange resins, its application in separation of ions, de-ionized water.

**Gas Chromatography:** Principle, theory and instrumentation (Block Diagram), Types of stationary phases and carrier gases (mobile phase), application of GC.

**High performance liquid chromatography:** Principle, theory and instrumentation, stationary phases and mobile phases. Applications of HPLC, analysis of Paracetamol.

#### **Recommended Text Books and Reference Books:**

1. Fundamentals of Molecular Spectroscopy, C.N. Ban well & Mc Cash.
2. Organic spectroscopy, William Kemp, Palgrave Macmillan; 2<sup>nd</sup> Revised edition.
3. Spectroscopy, B K Sharma Krishna Prakashan Media, 1981.
4. Elements of Organic spectroscopy, YR Sharma.
5. Applications of Absorption spectroscopy of Organic compounds ( English paper back, Dyer R.John)
6. Organic chemistry, Morrison and Boyd, Pearson Publications.
7. Introduction to Spectroscopy by Donald Pavia, Gary Lampman and George Kriz. Saunders College Division, 2001.
8. Chemistry text book for B.Sc., published by Telugu academy, Govt. of Telangana.
9. Analytical Chemistry by David Krupadanam, Universities Press (India) Limited.
10. Principles of Instrumental Analysis, D.A.Skoog, F.J.Holler & T.A. Nieman, Cengage Learning India Ed.
11. Fundamentals of Analytical Chemistry 6<sup>th</sup> Edn, D.A.Skoog, D.M. West, F.J.Holler, Saunders College Publishing, Fort worth (1992).
12. Instrumental Methods of Analysis, 7th Ed. Willard, H.H., Merritt, L.L., Dean, J. & Settle, F.A. Wordsworth Publishing Co.Ltd., Belmont, California, USA, 1988.
13. A Text Book of Quantitative Inorganic Analysis 7<sup>th</sup> Ed., Vogel, A.I. Prentice Hall.
14. Analytical Chemistry 7 th Edition by Gary D.Christian (2004)
15. Separation Methods, M.N Sastry, Himalaya Publication (2004)

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**B.Sc., III YEAR CHEMISTRY**

**SEMESTER-V**

**DSE-B: Chemistry Paper-V**

***(Metallurgy, Dyes and Catalysis)***

**(04 credits)**

**60 Hrs (04 Hrs/week)**

**Unit I: General Principles of Metallurgy and Production of Non Ferrous Metals (15 Hrs)**

**S5-E-B-I: Pyrometallurgy:** Drying and calcination, roasting, smelting, products of smelting,

**Hydrometallurgy:** Leaching methods, leaching agents, leaching of metals, oxides and sulphides.

Separation of liquid and solid phases and processing of aqueous solutions

**Electrometallurgy:** Electrolysis, Refining electrolysis, electrolysis from aqueous solutions, fused-salt electrolysis

**Refining processes:** Chemical and physical refining processes

**Production of selected non-ferrous metals (Copper, Nickel, Zinc):** Properties, raw materials, production (flow charts presentations and chemical reactions involved) and uses.

**Unit II: Natural and Synthetic Dyes (15 Hrs)**

**S5-E-B-II:** Definition and Classification of dyes - Natural dyes, Synthetic dyes: based on chemical constitution of dyes; Chemical nature of dyes; Application of dyes.

**Structures of Natural dyes:** Indigo, Tyrian purple, Alizarine, Indigotin.

**Structures of Synthetic dyes:** Nitro dyes, Nitroso dyes, Azo dyes (Mono azo dye, Bis azo dyes) Diaryl methane dyes, Triaryl methane dyes, Xanthenes dyes, Phenolphthalein, Fluoroseine, Acridine dyes.

**Synthesis of dyes:** Mono azo dye, Bis azo dyes (Congo red), Auromine O, Malachite Green, Crystal Violet, Rhodamine B, Acridine Yellow, Indigotin. Binding of dyes to fabric. Applications of dyes.

**Unit III: Catalysis-I (15 Hrs)**

**S5-E-B-III: Homogeneous and heterogeneous catalysis** - Definition of a catalyst and catalysis. Comparison of homogeneous and heterogeneous catalysis with specific examples. General characteristics of catalytic reactions.

**Acid-base catalysis-** Examples of acid and base catalysed reactions, hydrolysis of esters. Kinetics of acid catalysed reactions. Specific acid and general acid catalysis, Kinetics of base catalysed reactions. Specific base and general base catalysis. Examples- Aldol condensation and decomposition of nitramide, base catalysed conversion of acetone to di acetone alcohol, Mutarotation of Glucose. Effect of pH on reaction rate of acid and base catalysed reactions.

**Phase transfer catalysis:** Principle of phase transfer catalysis, classification of phase transfer catalysts. Factors influencing the rate of PTC reactions.

**Unit IV: Catalysis-II (15 Hrs)**

**S5-E-B-IV: Enzyme catalysis-** Characteristics of enzyme catalysis, Examples: (i) Invertase in inversion of cane sugar (ii) Maltase in conversion of maltose to glucose (iii) Urease in decomposition of urea (iv) Zymase in conversion of glucose to ethanol (v) working of carbonic anhydrase and (vi) Mechanism of oxidation ethanol by alcohol dehydrogenase. Factors affecting enzyme catalysis. Effect of temperature, pH, concentration and effect of inhibitor on enzyme catalysed reactions, Catalytic efficiency.

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Kinetics of enzyme catalysed reactions: Michaelis-Menton Equation. Mechanism of enzyme catalysed reactions. Significance of Michaelis constant ( $K_m$ ) and maximum velocity ( $V_{max}$ ), Lineweaver-Burk plot. Types of enzyme inhibitors.

**Recommended Text Books and Reference Books:**

1. Industrial Chemistry B.K.Sharma
2. Engineering Chemistry, Jain and Jain
3. Industrial Chemistry, E. Stocchi, Vol-I, Ellis Horwood Ltd. UK.
4. Handbook of Industrial Chemistry, J. A. Kent: Riegel's, CBS Publishers, New Delhi.
5. Theory of production of non-ferrous metals and alloys Study. Kateřina Skotnicová, Monika Losertová, Miroslav Kursa.
6. The Chemistry of Synthetic Dyes, Volume 4, K.Venkataraman, Elsevier.
7. Organic Chemistry Vol-I by I.L. Finar.
8. Organic Chemistry by Jennice, Gorzinski Smith.
9. Natural Dyes: Sources, Chemistry, Application and Sustainability Issues by Sujata Saxena and A. S. M. Raja.
10. Physical Chemistry by Atkins and De Paula, 8 th Edn.
11. Physical Chemistry by Puri, Sharma and Pattania, 2017.
12. Kinetics and mechanism of chemical transformations by Rajarajm and Kuriacose, Published by Macmillan India Ltd.
13. Text book of Physical Chemistry by K.L. Kapoor Macmillan, 1999.
14. Catalysis by J.C. Kuriacose, Macmillan Publishers India Limited, 1980.
15. Phase Transfer Catalysis, Fundamentals, Applications and Industrial perspectives, C.M.Stark, C.Liotta & M.Halpern, Academic Press.
16. Phase Transfer Catalysis, E.V.Dehmlow & S.S. Dehmlow, Verlag Chemie, Weinheim.

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**B.Sc., III YEAR CHEMISTRY**

**SEMESTER-V**

**LABORATORY COURSE**

**Paper –V: Experiments in Physical Chemistry-I**

**(01 Credit)**

**45 Hrs (03 Hrs/week)**

**1. Distribution law**

- a) Determination of molecular status and partition coefficient of benzoic acid in Toluene and water.
- b) Determination of distribution coefficient of acetic acid between n-butanol and water.

**2. Electrochemistry**

- a) Determination of cell constant of conductivity cell.
- b) Verification of Ostwald's dilution law- Determination of dissociation constant ( $K_a$ ) of acetic acid by conductivity measurements.

**3. Colorimetry**

- a) Verification of Beer's - Lamberts law for  $KMnO_4$
- b) Determination of the concentration of the given  $KMnO_4$  solution.

**4. Adsorption**

- a) Adsorption of acetic acid on animal charcoal- Verification of Freundlich adsorption isotherm.

**5. Physical constants**

- a) Surface tension and b) Viscosity of liquids. (Demonstration Experiment)

**Reference books:**

1. Senior Practical Physical Chemistry, B. D Khosla, V. C. Garg, Adarsh Gulati Published by R. Chand & Co.
2. Practical Physical Chemistry, B. Vishwanathan and P.S. Raghavan. Viva Books.
3. Practicals in Physical Chemistry by P.S. Sindhu ISBN-10: 1-4039-2916-5/1403929165 ISBN-13: 978-1-4039-2916-7/9781403929167.







## B.Sc., III YEAR CHEMISTRY

### SEMESTER-VI

#### DSE-A: Chemistry Paper-VI

*(Medicinal Chemistry)*

(04 credits)

60 Hrs (04 Hrs/week)

#### Unit- I: Introduction and Terminology (15 Hrs)

**S6-E-A-I: Diseases:** Common diseases, infective diseases—insect borne, air-borne, water-borne and hereditary diseases.

**Terminology in Medicinal Chemistry:** Drug, Active Pharmaceutical Ingredient (ADI), Pharmaceuticals, Pharmacology, Pharmacophore, Pharmacodynamics, Pharmacokinetics, metabolites, anti metabolites and therapeutic index.

**Drugs:** Nomenclature: Chemical name, Generic name and Trade names with examples; Classification: Classification based on structures and therapeutic activity with examples.

**ADMET:** a) Absorption: Definition, absorption of drugs across the membrane – active and passive absorption, routes of administration of drugs. b) Distribution: definition and effect of plasma protein binding. c) Metabolism: definition, phase I and phase II reactions. d) Elimination: definition and renal elimination. Toxicity.

#### Unit-II: Enzymes and Receptors (15 Hrs)

**S6-E-A-II: Enzymes: Introduction,** Mechanism and factors affecting enzyme action, Specificity of enzyme action (including stereo specificity), Enzyme inhibitors and their importance. Types of inhibition - reversible, irreversible and their subtypes with examples.

**Receptors:** Introduction, Drug action-receptor theory, Mechanism of drug action, concept of agonists and antagonists with examples. Drug receptor interactions involved in drug receptor complex. Binding role of -OH group, -NH<sub>2</sub> group, quaternary ammonium salts and double bond. Structure – activity relationships of drug molecules, explanation with sulfonamides.

#### Unit- III: Synthesis and Therapeutic Activity of Drugs (15 Hrs)

**S6-E-A-III:** Introduction, synthesis and therapeutic activity of:

**Chemotherapeutics:** Sulphanilamide, dapsone, Penicillin-G (semi synthesis), Chloroquin, Isoniazid, Cisplatin and AZT.

**Drugs to treat metabolic disorders:** Anti diabetic - Tolbutamide; Anti-inflammatory – Ibuprofen; Cardiovascular- Glyceryl trinitrate; Antipyretic (paracetamol, aspirin) and Antacid- Omeprazole.

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**Drugs acting on nervous system:** Anesthetics-definition, Classification-local and general. Volatile-Nitrous oxide, chloroform uses and disadvantages. Local anesthetics – benzocaine.

**Unit- IV: Molecular Messengers and Vitamins and Micronutrients (15 Hrs)**

**S6-E-A-IV: Molecular Messengers:** Introduction to hormones and neurotransmitters, Thyroid hormones, Antithyroid drug-Carbimazol. Adrenaline: Adrenergic drugs- salbutamol, atenelol. Serotonin: SSRIs- fluoxetine. Dopamine: Antiparkinson drug- Levodopa .

**Vitamins and Micronutrients:** Introduction, Vitamin sources, Deficiency disorders and remedy of Vitamins A,B, C, D, E, K and micronutrients – Na, K, Ca, Cu, Zn and I .

**Recommended Text Books and Reference Books:**

1. Introduction to Medicinal Chemistry, G.L. Patrick, Oxford University Press, New York. 2013.
2. Medicinal Chemistry, Thomas Nogrady, Oxford Univ. Press, New York.2005.
3. Foye's Principles of Medicinal Chemistry, David William and Thomas Lemke, Lippincott Williams & Wilkins, 2008.
4. Medicinal Chemistry, Ashutosh Kar, New Age International, 2005.
5. Synthetic Drugs, O.D.Tyagi & M.Yadav, Anmol Publications,1998.
6. Medicinal Chemistry, Alka L. Gupta, Pragati Prakashan.
7. Drugs, G. L. David Krupadanam, D.Vijaya Prasad, K.Varaprasad Rao, K. L. N. Reddy, C. Sudhakar, Universities Press (India) Ltd. 2012.

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## B.Sc., III YEAR CHEMISTRY

### SEMESTER-VI

#### DSE-B: Chemistry Paper-VI

*(Agricultural & Fuel Chemistry)*

(04 credits)

60 Hrs (04 Hrs/week)

#### Unit I: Pesticides (15 Hrs)

**S6-E-B-I: Introduction**, Definition, classification of pesticides based on use (target). Toxicity and chemical structure with examples. Adverse effects of pesticides and its impact on environmental pollution.

Synthesis, manufacture and uses of representative pesticides: Organochlorines (Cypermethrin); Organophosphates (Parathion); Carbamates (carbaryl); Quinones (Chloranil), Anilides (Alachlor).

**Pesticide formulations:** Dusts, Granules, Wettable powders, Emulsions and Aerosols.

**Biopesticides :** Introduction: Potential pesticidal plants of India, Role of Neem in plant protection-constituents, Azadirachtin and its role in pest control, Structure and mode of action of Pyrethrins (pyrethrin-1) and Pyrethroids (permethrin) and nicotinoids (Imidacloprid).

#### Unit II: Fertilizers (15Hrs)

**S6-E-B-II: Introduction:** (need of fertilizers), functions of essential plant nutrients (N, P, K), Classification formula and uses of fertilizers:

**Nitrogenous fertilizers:** Ammonium nitrate, Urea, Calcium Cyanamide, Calcium Ammonium Nitrate, Sodium Nitrate, Ammonium Chloride and their uses.

**Phosphate fertilizers:** Normal super phosphate, Triple Super Phosphate, Ammonium Phosphate and their uses.

**Potassium fertilizers:** Potassium chloride, potassium nitrate, potassium sulphate and uses.

**Complex fertilizers:** Diaammonium Phosphate and mixed fertilizers their uses. Manufacture of urea and Super phosphate of lime and their reactions in the soil.

**Biofertilizers:** Introduction, definition, classification, Rhizobium, Azatobactor, Azospirillum, Azolla, Blue Green Algae, Vermicomposting and uses.

**Organic farming:** The principal methods, crop rotation, green manures and compost, biological pest control, and mechanical cultivation and uses.

#### Unit III: Energy Sources and Coal (15Hrs)

**S6-E-B-III:** Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.



**Coal:** Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar based chemicals, requisites of a good metallurgical coke, Coal gasification (Hydro gasification and Catalytic gasification), Coal liquefaction and Solvent Refining.

#### **Unit IV: Petroleum and its products, Petrochemicals and non petroleum fuels (15Hrs)**

##### **S6-E-B-IV: Petroleum and its products**

**Petroleum:** Origin, Composition of crude petroleum and classification. Properties-flash point and its determination, Knocking and anti-knocking compounds; Octane number and Cetane number. Distillation of crude petroleum, Fractional Distillation - Principle and process, refining, fractions and uses. Cracking -Thermal and catalytic cracking, Reforming.

**Petroleum products** – Petrol, Diesel, LPG, Kerosene, Tar and their applications.

**Petrochemicals**-Vinyl acetate, Propylene oxide, Isoprene and their uses.

**Lubricants:** Classification of lubricants- Solid, semi solid and liquids; Properties (viscosity, flash point, fire point, cloud point, pour point) and their determination. Functions of Lubricants, Mechanism of lubrication.

**Non-Petroleum fuels:** Natural Gas- CNG, LNG, clean Fuels- H<sub>2</sub> gas, ethanol, Fuel from waste- bio gas, Fuel from bio mass-Bio ethanol, biodiesel, and Synthetic fuels- syngas based.

##### **Recommended Text Books and Reference Books:**

1. Chemistry of pesticides, N. N. Melnikov, Springer-Verlag- Technology & Engineering (2012).
2. Pesticide Synthesis, Thomas A. Unger, Elsevier, (2000).
3. Pesticides, R. Cremllyn, John Wiley, 1980.
4. Manures and Fertilisers, K. Kolay, Published by Atlantic (2007).
5. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).
6. A Text Book of Engineering Chemistry Paperback-2017 by Shashi Chawla.
7. Industrial Chemistry, Vol-I, Stocchi.E, Ellis Horwood Ltd. UK (1990).
8. Jain, P.C. & Jain, M. Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
9. Engineering Chemistry by Shashi Chawla, Dhanpat Rai & Sons, Delhi.

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**B.Sc., III YEAR CHEMISTRY**

**SEMESTER-VI**

**LABORATORY COURSE**

**Paper –V: Experiments in Physical Chemistry-II**

**(01 Credit)**

**45 Hrs (03 Hrs/week)**

**1. Kinetics**

- a) Determination of specific reaction rate of the hydrolysis of methyl acetate catalyzed by hydrogen ion at room temperature.
- b) Determination rate of decomposition of hydrogen peroxide catalyzed by  $\text{FeCl}_3$ .

**2. Electrochemistry**

**A. Potentiometry:**

- a) Determination of redox potential of  $\text{Fe}^{2+}/\text{Fe}^{3+}$  by potentiometric titration of ferrous ammonium sulphate vs potassium dichromate.
- b) Precipitation titration of  $\text{KCl}$  vs  $\text{AgNO}_3$  –Determination of given concentration of silver nitrate.

**B. pH metry:**

- a) pH metric titration of strong acid ( $\text{HCl}$ ) vs strong base- Determination of the concentration of given acid.
- b) pH metric titration of strong acid (acetic acid) with strong base ( $\text{NaOH}$ )- Determination of acid dissociation constant ( $K_a$ ) of weak acid.

**3. Conductometry:**

- a) Determination of overall order: Saponification of ethyl acetate with  $\text{NaOH}$  by conductance measurement

**Reference books:**

1. Senior practical physical chemistry, B.D.Khosla, V.C.Garg, Adarsh Guati.
2. Advanced Practical Physical chemistry, J.B.Yadav.
3. Practical Physical chemistry, B.Vishvanathan and P.S.Raghavan.
4. Practical Physical chemistry, P.S. Sindhu.

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