

**A.S.D. GOVERNMENT DEGREE COLLEGE FOR WOMEN (A)  
KAKINADA – 533 002, EAST GODAVARI, A.P.**

**DEPARTMENT OF CHEMISTRY**



**SYLLABUS**

**2022-23**

**A.S.D. GOVERNMENT DEGREE COLLEGE FOR WOMEN (A), KAKINADA**

**DEPARTMENT OF CHEMISTRY**

**SEMESTER – I**

**Course I (Inorganic & Physical Chemistry) 60 hrs. (4h/w)**

**Course outcomes:**

**At the end of the course, the student will be able to;**

1. Understand the basic concepts of p-block elements.
2. Explain the difference between solid, liquid and gases in terms of intermolecular interactions.
3. Apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses.

**INORGANIC CHEMISTRY**

**24h**

**UNIT –I**

**Chemistry of p-block elements**

**8h**

**Group 13:** Preparation & structure of Diborane, Borazine

**Group 14:** Preparation, classification and uses of silicones

**Group 15:** Preparation & structures of Phosphonitrihalides,  $\{(\text{PNCl}_2)_n$  where  $n=3,4$

**Group 16:** Oxides and Oxoacids of Sulphur (structures only)

**Group 17:** Pseudo halogens, Structures of Inter halogen compounds.

**UNIT-II**

**1. Chemistry of d- block elements**

**6 h**

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.

**2. Chemistry of f-block Elements**

**6 h**

Chemistry of lanthanides - electronic structure, oxidation states, lanthanide contraction, consequences of lanthanide contraction, magnetic properties. Chemistry of actinides - electronic configuration, oxidation states, actinide contraction, comparison of lanthanides and actinides.

**3. Theories of Bonding in Metals**

**4 h**

Valence bond theory and Free electron theory, explanation of thermal and electrical conductivity of metals based on these theories, Band theory- formation of bands, explanation of conductors, semiconductors and insulators.

## **PHYSICAL CHEMISTRY**

**36h**

### **UNIT-III**

#### **Solid state**

**10h**

Symmetry in crystals. Law of constancy of interfacial angles. The law of rationality of indices. The law of symmetry. Miller indices, Definition of lattice point, space lattice, unit cell. Bravais lattices and crystal systems. X-ray diffraction and crystal structure. Bragg's law. Powder method. Defects in crystals. Stoichiometric and non-stoichiometric defects.

### **UNIT-IV**

#### **Gaseous State**

**6h**

Van der Waal's equation of state. Andrew's isotherms of carbon dioxide, continuity of state. Critical phenomena. Relationship between critical constants and vander Waal's constants. Law of corresponding states. Joule- Thomson effect. Inversion temperature.

#### **Liquid state**

**4h**

Liquid crystals, mesomorphic state. Differences between liquid crystal and solid/liquid. Classification of liquid crystals into Smectic and Nematic. Application of liquid crystals as LCD devices.

### **UNIT-V**

#### **Solutions, Ionic equilibrium & dilute solutions**

##### **1. Solutions**

**6h**

Azeotropes-HCl-H<sub>2</sub>O system and ethanol-water system. Partially miscible liquids-phenol-water system. Critical solution temperature (CST), Effect of impurity on consolute temperature. Immiscible liquids and steam distillation. Nernst distribution law. Calculation of the partition coefficient. Applications of distribution law.

##### **2. Ionic Equilibrium**

**3 h**

Ionic product, common ion effect, solubility and solubility product. Calculations based on solubility product.

##### **3. Dilute Solutions**

**7 h**

Colligative properties- RLVP, Osmotic pressure, Elevation in boiling point and depression in freezing point. Experimental methods for the determination of molar mass of a non-volatile solute using osmotic pressure, Elevation in boiling point and depression in freezing point. Abnormal colligative properties. Van't Hoff factor.

### List of Reference Books

1. Principles of physical chemistry by Prutton and Marron
2. Solid State Chemistry and its applications by Anthony R. West
3. Text book of physical chemistry by K L Kapoor
4. Text book of physical chemistry by S Glasstone
5. Advanced physical chemistry by Bahl and Tuli
6. Inorganic Chemistry by J.E.Huheey
7. Basic Inorganic Chemistry by Cotton and Wilkinson
8. A textbook of qualitative inorganic analysis by A.I. Vogel
9. Atkins,P.W.&Paula,J.deAtkin'sPhysicalChemistryEd.,OxfordUniversityPress 10thEd(2014).
10. Castellan,G.W.PhysicalChemistry4thEd.Narosa(2004).
11. Mortimer,R. G.PhysicalChemistry3rdEd. Elsevier:NOIDA,UP(2009).
12. Barrow,G.M.PhysicalChemistry

### LABORATORY COURSE -I

30hrs (2 h / w)

**Practical-I** Analysis of SALT MIXTURE(At the end of Semester-I)

**Qualitative inorganic analysis (Minimum of Six mixtures should be analyzed)**

### Analysis of SALT MIXTURE

50 M

Analysis of mixture salt containing two anions and two cations (From two different groups)from the following:

**Anions:** Carbonate, Sulphate, Chloride, Bromide, Acetate, Nitrate, Borate, Phosphate.

**Cations:** Lead, Copper, Iron, Aluminium, Zinc, Nickel, Manganese, Calcium, Strontium,Barium, Potassium and Ammonium.

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**SEMESTER – II**

**Course II – (Organic & General Chemistry) 60 h (4h/w)**

**UNIT-I**

**Carbon-Carbon sigma bonds (Alkanes and Cycloalkanes) 12h**

General methods of preparation of alkanes- Wurtz and Wurtz Fittig reaction, Corey House synthesis, physical and chemical properties of alkanes, Isomerism and its effect on properties, Free radical substitutions; Halogenation, concept of relative reactivity v/s selectivity. Conformational analysis of alkanes (Conformations, relative stability and energy diagrams of Ethane, Propane and butane). General molecular formulae of cycloalkanes and relative stability, Baeyer strain theory, Cyclohexane conformations with energy diagram, Conformations of mono substituted cyclohexane.

**UNIT-II**

**Carbon-Carbon pi Bonds (Alkenes and Alkynes) 12h**

General methods of preparation, physical and chemical properties. Mechanism of E1, E2, reactions, Saytzeff and Hoffmann eliminations, Electrophilic Additions, mechanism (Markonikoff / Anti Markonikoff addition) with suitable examples, syn and anti-addition of H<sub>2</sub>, HX, X<sub>2</sub>. Oxymercuration, Hydroboration-Oxidation, Ozonolysis, Hydroxylation, Diels Alder reaction, 1,2-and 1,4-addition reactions in conjugated dienes. Reactions of alkynes, acidity, electrophilic and nucleophilic additions, Hydration to form carbonyl compounds. Alkylation of terminal alkynes.

**UNIT-III**

**Benzene and its reactivity ( 12h)**

Concept of aromaticity, Huckel's rule - application to Benzenoid (Benzene, Naphthalene) and Non - Benzenoid compounds (cyclopropenyl cation, cyclopentadienyl anion and tropylium cation) Reactions - General mechanism of electrophilic aromatic substitution, mechanism of nitration, Friedel- Craft's alkylation and acylation. Orientation of aromatic substitution - ortho, para and meta directing groups. Ring activating and deactivating groups with examples (Electronic interpretation of various groups like NO<sub>2</sub> and Phenolic). Orientation of i) amino, methoxy and methyl groups ii) Carboxy, Nitro, carbonyl and sulphonic acid groups iii) halogens

## **GENERAL CHEMISTRY (24 h)**

### **UNIT-IV**

#### **Surface chemistry and chemical bonding**

##### **1. Surface chemistry (6h)**

Colloids- Coagulation of colloids- Hardy-Schulze rule. Stability of colloids, Protection of Colloids, Gold number.

**Adsorption**-Physical and chemical adsorption, Langmuir adsorption isotherm, applications of adsorption.

##### **2. Chemical Bonding (6h)**

Valence bond theory, hybridization, VB theory as applied to  $\text{ClF}_3$ ,  $\text{Ni}(\text{CO})_4$ , Molecular orbital theory - LCAO method, construction of M.O. diagrams for homo-nuclear and hetero-nuclear diatomic molecules ( $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{CO}$  and  $\text{NO}$ ).

##### **3. HSAB(2h)**

Pearson's Concept, HSAB principle and its importance, bonding in hard-hard and soft-soft combinations.

### **UNIT-V**

#### **Stereochemistry of carbon compounds (10h)**

Molecular representations- Wedge, Fischer, Newman and Saw-Horse formulae. Optical isomerism: Optical activity- wave nature of light, plane polarized light, optical rotation and specific rotation. Chiral molecules- definition and criteria (Symmetry elements)- Definition of enantiomers and diastereomers – Explanation of optical isomerism with examples- Glyceraldehyde, Lactic acid, Alanine, Tartaric acid. 2, 3 – dibromo pentane, D, L, R, S and E, Z- configuration with examples. Definition of racemic mixture-resolution of racemic mixtures.

**A.S.D. GOVERNMENT DEGREE COLLEGE FOR WOMEN (A), KAKINADA**  
**DEPARTMENT OF CHEMISTRY**  
**SECOND YEAR, SEMESTER- III**  
**Paper III (ORGANIC CHEMISTRY & SPECTROSCOPY) 60 h (4 h / w)**

**ORGANIC CHEMISTRY 30 h (2h / w)**

**UNIT -I**

**Chemistry of Halogenated Hydrocarbons:** Alkyl Halides: Methods of preparation and properties, nucleophilic substitution reactions– SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination, Williamson's synthesis. Aryl Halides: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; SN Ar, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

**1. Alcohols & Phenols**

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvet Blanc Reduction; Oxidation Of Diols By Periodic Acid and lead Tetraacetate, Pinacol- Pinacolone Rearrangement;

Phenols: Preparation and Properties; Acidity and Factors Affecting It, Ring substitution reactions, Reimer-Tieman and Kolbe's-Schmidt Reactions, Fries and Claisen Rearrangement with mechanism.

**UNIT II:**

**Carbonyl Compounds:** Structure, reactivity, preparation and properties; Nucleophilic Addition, Nucleophilic Addition-elimination reactions with ammonia derivatives Mechanisms of Aldol and Benzoin Condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann Haloform Reaction And Baeyer Villiger oxidation,  $\alpha$ -substitution reactions, oxidations and reductions (Clemmensen, Wolf-Kishner, with LiAlH<sub>4</sub> & NaBH<sub>4</sub>). Addition Reactions Of  $\alpha$ ,  $\beta$ -unsaturated carbonyl compounds: Michael Addition. Active Methylene Compounds: Keto-enol tautomerism. Preparation and Synthetic Applications Diethyl malonate and ethyl acetoacetate.

### UNIT III:

**Carboxylic Acids and their Derivatives:** General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituent acidic strength. Typical reactions of carboxylic acids, hydroxy acids and unsaturated acids. Preparation And Reactions Of Acid Chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group-Mechanism of acidic and alkaline hydrolysis of esters, Claisen Condensation, Reformatsky reactions and Curtius Rearrangement 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 Schmidt reaction, Arndt- Eistert synthesis, halogenation by Hell- Volhard- Zelensky reaction.

### SPECTROSCOPY

**30 h (2h / w)**

### UNIT –IV

**Molecular Spectroscopy:** Interaction of electromagnetic radiation with molecules and various types of spectra;

**Rotation spectroscopy:** Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

**Vibrational Spectroscopy:** Classical Equation of Vibration, computation of force constant, Harmonic and anharmonic oscillator, Morse Potential curve, vibrational degrees of freedom for polyatomic molecules, modes of vibration. Selection rules for vibrational transitions, Fundamental Frequencies, overtones and hot bands.

**Electronic spectroscopy:** Energy levels of molecular orbitals ( $\sigma$ ,  $\pi$ ,  $n$ ). Selection rules for electronic spectra. Types of electronic transitions in molecules, effect of conjugation. Concept of chromophore. bathochromic and hypsochromic shifts. Beer-Lambert's law and its limitations.

**Nuclear Magnetic Resonance (NMR) spectroscopy:** 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.



## **UNIT-V**

### **Application of Spectroscopy to Simple Organic Molecules**

Application of visible, ultraviolet and Infrared spectroscopy in organic molecules. Application of electronic spectroscopy and Woodward rules for calculating  $\lambda_{\text{max}}$  of conjugated dienes and  $\alpha$ ,  $\beta$  – unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on  $>\text{C}=\text{O}$  stretching absorptions).

### **REFERENCE BOOKS:**

1. A TextBook of Organic Chemistry by Bahl and Arunbahl
2. A Textbook of Organic chemistry by I L Finar Vol I
3. Organic chemistry by Bruice
4. Organic chemistry by Clayden
5. Spectroscopy by William Kemp
6. Spectroscopy by Pavia
7. Organic Spectroscopy by J. R. Dyer
8. Elementary organic spectroscopy by Y.R. Sharma
9. Spectroscopy by P.S.Kalsi
10. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
11. Spectrometric Identification of Organic Compounds by Robert M Silverstein, Francis X Webster
12. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012)
13. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,

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LABORATORY COURSE -III      30hrs (2 h / w)

**Practical Paper-III** (At the end of Semester-III)

**Organic Preparations and IR Spectral Analysis Lab : 50 Marks**

**Organic preparations: 40M**

i. Acetylation of one of the following compounds:

amines (aniline, o-, m-, p- toluidine and o-, m-, p-anisidine) and phenols ( $\beta$ -naphthol, vanillin, salicylic acid) by any one method:

a. Using conventional method.

b. Using green approach

ii. Benzoylation of one of the following amines

(aniline, o-, m-, p- toluidine and o-, m-, p-anisidine)

a. Nitration of any one of the following: Acetanilide/nitrobenzene by conventional method

b. Salicylic acid by green approach (using ceric ammonium nitrate).

**IR Spectral Analysis: 10M**

IR Spectral Analysis of the following functional groups with examples

a) Hydroxyl groups

b) Carbonyl groups

c) Amino groups

d) Aromatic groups

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**SECOND YEAR, SEMESTER– IV**  
**Paper IV (Course 4) INORGANIC, ORGANIC & PHYSICAL CHEMISTRY**  
**60 h (4 h / w)**

**UNIT I:**

**Organometallic Compounds:** Definition and classification of organometallic compounds on the basis of bond type, Concept of hapticity of organic ligands. Metal Carbonyls: 18electronrule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation of mono and binuclear carbonyls of 3d series. P-acceptor behaviour of carbon monoxide. Synergic effects (VB approach) - (MO diagram of CO can be referred to for synergic effect to IR frequencies).

**UNIT II:**

**Carbohydrates:** Occurrence, classification and their biological importance, Monosaccharides: Constitution and absolute configuration glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth Projection And Conformational Structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides– Elementary Treatment Of Maltose, lactose and sucrose. Polysaccharides–Elementary Treatment Of starch.

**UNIT III:**

**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) Gabriel Phthalimide synthesis c) strecker's synthesis.

Physical properties: Zwitter ion 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.

**Heterocyclic Compounds:** Introduction and definition: Simple five membered ring compounds with one hetero atom Ex. Furan. Thiophene and pyrrole - Aromatic character – Preparation from 1, 4, -dicarbonyl compounds, Paul-Knorr synthesis. Properties: Acidic character of pyrrole - electrophilic substitution at 2 or 5 position, Halogenation, Nitration and Sulphonation under mild conditions - Diels Alder reaction in furan. Pyridine – Structure

- Basicity - Aromaticity- Comparison with pyrrole- one method of preparation and properties - Reactivity towards Nucleophilic substitution reaction.

#### **UNIT IV:**

**Nitrogen Containing Functional Groups:** Preparation, properties and important reactions of nitro compounds, amines and diazonium salts.

##### **1. Nitro hydrocarbons**

Nomenclature and classification-nitro hydrocarbons, structure -Tautomerism of nitroalkanes leading to aci and keto form, Preparation of Nitroalkanes, reactivity -halogenation, reaction with HONO (Nitrous acid), Nef reaction and Mannich reaction leading to Micheal addition and reduction.

##### **2.Amines:**

Introduction, classification, chirality in amines (pyramidal inversion), importance and general methods of preparation.

**Properties:** Physical properties, Basicity of amines: Effect of substituent, solvent and steric effects. Distinction between Primary, secondary and tertiary amines using Heinsberg's Method and Nitrous Acid. Discussion of the following reactions with emphasis on the mechanistic pathway: Gabriel Phthalimide synthesis, Hoffmann- Bromamide Reaction, Carbylamine Reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction and Cope elimination.

**Diazonium Salts:** Preparation and synthetic applications of diazonium salts including preparation of arenes, haloarenes, phenols, amino and nitro compounds. Coupling Reactions of Diazonium Salts (preparation of azo dyes).

#### **UNIT V:**

**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 reaction mechanism- hydrogen- chlorine and hydrogen- bromine reaction. Qualitative description of fluorescence, phosphorescence, Jablonski diagram, Photosensitized reactions- energy transfer processes (simple example).

**Thermodynamics:** The first law of thermodynamics-statement, definition of internal energy and enthalpy, Heat capacities and their relationship, Joule-Thomson effect- coefficient, Calculation of work for the expansion of perfect gas under isothermal and adiabatic conditions for reversible processes, State function. Temperature dependence of enthalpy of formation- Kirchhoff's equation, Second law of thermodynamics Different Statements of the law, Carnot cycle and its efficiency, Carnot theorem, Concept of entropy, entropy as a state function, entropy changes in reversible and irreversible processes. Entropy changes in spontaneous and equilibrium processes. Third law of thermodynamics, Nernst heat theorem,

Spontaneous and non-spontaneous processes, Helmholtz and Gibbs Energies-Criteria for spontaneity.

Continuous Evaluation: Monitoring the progress of student's learning Class Tests, Worksheets and Quizzes Presentations, Projects and Assignments Group Discussions: Enhances Critical Thinking Skills And personality

**REFERENCE BOOKS:**

1. Concise coordination chemistry by Gopalan and Ramalingam
2. Coordination Chemistry by Basalo and Johnson
3. Organic Chemistry by G.Mareloudan, Purdue Univ
4. Text book of physical chemistry by S Glasstone
6. Concise Inorganic Chemistry by J.D.Lee
7. Advanced Inorganic Chemistry Vol-I by Satyaprakash, Tuli, Basu and Madan
8. A Text Book of Organic Chemistry by Bahl and Arunbahl
9. A Text Book of Organic chemistry by I L FinarVol I
10. A Text Book of Organic chemistry by I L FinarVol II

**LABORATORY COURSE -IV                      30hrs (2 h / w)**

**Practical Paper-IV** (At the end of Semester-IV)

**(Course-4L) Organic Qualitative analysis Lab: 50 Marks**

**Organic Qualitative analysis 50 M**

Analysis of an organic compound through systematic qualitative procedure for functional group identification including the determination of melting point and boiling point with suitable derivatives.

Alcohols, Phenols, Aldehydes, Ketones, Carboxylic acids, Aromatic primary amines, amides and simple sugars

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**SECOND YEAR, SEMESTER– IV**  
**Paper IV (Course 5) (INORGANIC&PHYSICAL CHEMISTRY) 60 h (4 h / w)**

**INORGANIC CHEMISTRY**

**UNIT I:**

**Coordinator Chemistry:** IUPAC nomenclature of coordination compounds, Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Valence Bond Theory (VBT): Inner and outer orbital complexes. Limitations of VBT, Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry, Factors affecting the magnitude of crystal field splitting energy, Spectrochemical series, Comparison of CFSE for Octahedral and Tetrahedral complexes, Tetragonal distortion of octahedral geometry, Jahn-Teller distortion, square planar coordination.

**UNIT II:**

**1. Inorganic Reaction Mechanism:**

Introduction to inorganic reaction mechanisms. Concept of reaction pathways, transition state, intermediate and activated complex. Labile and inert complexes, ligand substitution reactions -SN1 and SN2, Substitution reactions in square planar complexes, Trans-effect, theories of trans effect and its applications

**2. 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.

**Bioinorganic Chemistry:**

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals, Sodium / K - pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cis-platin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin, Myoglobin. Storage and transfer of iron.

## PHYSICAL CHEMISTRY

### UNIT-III:

**1 .Phase rule:** Concept of phase, components, degrees of freedom. Thermodynamic derivation of Gibbs phase rule. Phase diagram of one component system - water system, Study of Phase diagrams of Simple eutectic systems i) Pb-Ag system, desilverisation of lead ii) NaCl-Water system, Congruent and incongruent melting point- Definition and examples for systems having congruent and incongruent melting point , freezing mixtures.

### UNIT IV:

**Electrochemistry:** Specific conductance, equivalent conductance and molar conductance- Definition and effect of dilution. Cell constant. Strong and weak electrolytes, Kohlrausch's law and its applications, Definition of transport number, determination of transport number by Hittorf's method. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only), Application of conductivity measurements- conductometric titrations. Electrochemical Cells- Single electrode potential, Types of electrodes with examples: Metal-metal ion, Gas electrode, Inert electrode, Redox electrode, Metal-metal insoluble salt- salt anion. Determination of EMF of a cell, Nernst equation, Applications of EMF measurements - Potentiometric titrations. Fuel cells- Basic concepts, examples and applications

### UNIT V:

#### **Chemical Kinetics:**

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Enzyme catalysis- Specificity, factors affecting enzyme catalysis, Inhibitors and Lock & key model. Michaels- Menten equation- derivation, significance of Michaelis-Menten constant.

## **REFERENCE BOOKS:**

1. Text book of physical chemistry by S Glasstone
2. Concise Inorganic Chemistry by J.D.Lee
3. Advanced Inorganic Chemistry Vol-I by Satyaprakash, Tuli, Basu and Madan
4. Advanced physical chemistry by Gurudeep Raj
5. Principles of physical chemistry by Prutton and Marron
6. Advanced physical chemistry by Bahl and Tuli
7. Inorganic Chemistry by J.E.Huheey
8. Basic Inorganic Chemistry by Cotton and Wilkinson
9. A textbook of qualitative inorganic analysis by A.I. Vogel
10. Atkins, P.W. & Paula, J.de Atkin's Physical Chemistry Ed., Oxford University Press 10thEd(2014)
11. Castellan, G.W.PhysicalChemistry, 4thEd.Narosa(2004)
12. Mortimer,R. G.PhysicalChemistry3rdEd. Elsevier:NOIDA,UP(2009).



**LABORATORY COURSE -IV      30hrs (2 h / w)**

**Practical Paper-IV (At the end of Semester-IV)**

**(Course-5L) Conductometric and Potentiometric Titrimetry Lab : 50 Marks**

**Conductometric and Potentiometric Titrimetry 50 M**

1. **Conductometric titration-** Determination of concentration of HCl solution using standard NaOH solution.
2. **Conductometric titration-** Determination of concentration of CH<sub>3</sub>COOH Solution using standard NaOH solution.
3. **Conductometric titration-** Determination of concentration of CH<sub>3</sub>COOH and HCl in a mixture using standard NaOH solution.
4. **Potentiometric titration-** Determination of Fe (II) using standard K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> solution.
5. Determination of rate constant for acid catalyzed ester hydrolysis.

## Course 6-A: Synthetic Organic Chemistry

### **Unit-1: Pericyclic reactions**

**12 hours**

1. A brief introduction to synthetic organic chemistry
2. Features and classification of pericyclic reactions: Phases, nodes and symmetry properties of molecular orbitals in ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene, alkylation and allyl radical. Thermal and photochemical reactions.
3. Electrocyclic reactions: Definition and examples, definitions of con and dis rotation, Woodward-Hoffmann selection rules. (Correlation diagrams are not required)
4. Cycloaddition reactions: Definition and examples, definitions of suprafacial and antarafacial addition, Woodward-Hoffmann selection rules. (Correlation diagrams are not required)

### **Unit-2: Organic photochemistry**

**8 hours**

1. Jablonski diagram-singlet and triplet states
2. Photochemistry of Carbonyl compounds- $n-\pi$  and  $\pi-\pi^*$  transitions, Norrish type-1 and type-2 reactions
3. Paterno-Buchi reaction.

### **Unit-3: Retro synthesis**

**12 hours**

1. Important terms in Retro synthesis with examples-Disconnection, Target molecule, FGI, Synthon, Retro synthetic analysis, chemo selectivity, region selectivity
2. Importance of Order of events in organic synthesis
3. Retro synthetic analysis of the compounds: a. cyclohexene, b. 4-Nitro toluene, c. Paracetamol.

### **Unit-4: Synthetic Reactions**

**8 hours**

Shapiro reaction, Stork - enamine reaction (only alkylation), Wittig reaction, Robinson annulation, Baily-Hillman reaction, Heck reaction, Suzuki coupling. Synthesis of aldehydes and ketones using 1, 3-Dithiane.

### **Unit-5: Reagents in Organic Chemistry**

**10 hours**

Oxidizing agents: PCC, PDC, SeO<sub>2</sub> (Riley oxidation), NBS.

Reducing agents: LiAlH<sub>4</sub> (with mechanism), LTBA, Metal-solvent reduction (Birch reduction), Catalytic reduction.

## 1. References

1. Peri cyclic reactions by Ian Fleming, Second edition, Oxford University press.
2. Peri cyclic Reactions-A Text book: Reactions, Applications and Theory by S. Sankararaman, WILEY-VCH.
3. Reaction Mechanism in Organic Chemistry by S.M. Mukherji and S.P.Singh, Revised edition, Trinity Press.
4. Pericyclic reactions-A Mechanistic study by S.M.Mukherji, Macmillan India.
5. Organic synthesis: The disconnection approach by Stuart Warren, John Wiley & Sons.
6. Organic chemistry by Jonathan Clayden, Nick Greeves and Stuart Warren, Second edition, Oxford university press.
7. Reactions, Reagents and Rearrangements by S.N. Sanyal, Bharati Bhawan Publishers & Distributors.

## Course6-A: Synthetic Organic Chemistry-PRACTICAL SYLLABUS

### **I. Practical (Laboratory) Syllabus :(30hrs)**

(Max.50 Marks)

1. Green procedure for organic qualitative analysis: Detection of N, S and halogens
2. Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
3. Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
4. Separation of mixture of methyl orange and methyl blue by column chromatography
5. Separation of food dyes using Column Chromatography
6. Separation of triglycerides using TLC

### **II. Lab References:**

1. Vogel A. I. Practical Organic Chemistry, Longman Group Ltd.
2. Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
3. Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, University press.
4. Mann F. G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

## Course 7-A: Analysis of Organic Compounds

### **Unit-1: Mass Spectrometry**

**10 hours**

A brief introduction to analysis of organic compounds

Basic principles, Instrumentation - Mass spectrometer, electron Ionization (Electron Impact ionization, EI), Molecular ions, metastable ions, Isotope abundance. Basic fragmentation types. Fragmentation patterns in Toluene, 2-Butanol, But aldehyde, Propionic acid.

### **Unit-2: Structural elucidation of organic compounds using IR, NMR, mass spectral data-**

**8 hours**

2, 2, 3, 3-Tetra methyl butane, Butane-2, 3-dione, Prop ionic acid and methyl propionate.

### **Unit-3: Structural elucidation of organic compounds using IR, NMR,**

#### **Mass spectral data**

**8 hours**

Phenyl acetylene, ace to phenomenon amici acid and p-nitro aniline.

### **Unit-4: Separation techniques-1**

**12 hours**

1. Solvent extraction-Principle and theory, Batch extraction technique, application of batch extraction in the separation of organic compounds from mixture- acid & neutral, base & neutral.
2. Chromatography- Principle and theory, classification, types of adsorbents, eluents, R<sub>f</sub> values and factors affecting R<sub>f</sub> values.
3. Thin layer chromatography-principle, experimental procedure, advantages and applications.

### **Unit-5: Separation techniques-2**

**12 hours**

1. Paper chromatography- Principle, experimental procedure, ascending, descending, radial and two dimensional, applications.
2. Column chromatography-Principle, classification, experimental procedure, applications.
3. HPLC-Principle, Instrumentation-block diagram and applications.
4. Organic Spectroscopy by William Kemp, Third Edition, Palgrave USA.
5. Introduction to Spectroscopy by Pavia, Lamp man, Kriza and Vyvyan, Fifth edition, Cengage.

## **Course7-A: Analysis of Organic Compounds - PRACTICAL SYLLABUS**

**Practical (Laboratory) Syllabus:(30hrs)**

(Max.50 Marks)

6. Identification of various equipment in the laboratory.
7. Acetylating of 1<sup>o</sup> amine by green method: Preparation of acetanilide
8. Rearrangement reaction in green conditions: Benzil - Benzilic acid rearrangement
9. Radical coupling reaction: Preparation of 1,1-bis -2-naphthol
10. Green oxidation reaction: Synthesis of adipic acid
11. Preparation and characterization of biodiesel from vegetable oil/ waste cooking oil
12. Photo reduction of Benzophenone to Benzopinacol in the presence of sunlight.
13. Separation of organic compounds in a mixture (acidic compound + neutral compound) using solventextraction.
14. Separation of organic compound
15. ds in a mixture (basic compound +neutral compound) using solventextraction.

### **II. Lab References:**

1. Vogel A. I. Practical Organic Chemistry, Longman Group Ltd.
2. Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
3. Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, Universitypress.
4. Mann F.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

## Course6-B: Analytical Methods in Chemistry-1

### **I. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Identify the importance of solvent extraction and ion exchange method.
2. Acquire knowledge on the basic principles of volumetric analysis and gravimetric analysis.
3. Demonstrate the usage of common laboratory apparatus used in quantitative analysis.
4. Understand the theories of different types of titrations.
5. Gain knowledge on different types of errors and their minimization methods.

### **II. Syllabus:**

*(Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.)*

#### **Unit-1: Quantitative analysis-1**

**8 hours**

1. A brief introduction to analytical methods in chemistry
2. Principles of volumetric analysis, concentration terms- Molarity, Molality, Normality, v/v, w/v, ppm and ppb, preparing solutions- Standard solution, primary standards and secondary standards.
2. Description and use of common laboratory apparatus- volumetric flask, burette, pipette, beakers, measuring cylinders.

#### **Unit-2: Quantitative analysis-2**

**12hours**

1. Principles of volumetric analysis: Theories of acid-base (including study of acid-base titration curves), redox, complex metric, iodometric and precipitation titrations-choice of indicators for the saturations.
2. Principles of gravimetric analysis: precipitation, coagulation, peptization, co precipitation, post precipitation, digestion, filtration, and washing of precipitate, drying and ignition.

#### **Unit-3: Treatment of analytical data**

**8hours**

Types of errors- Relative and absolute, significant figures and its importance, accuracy - methods of expressing accuracy, errors- Determinate and indeterminate and minimization of errors, precision-methods of expressing precision, standard deviation and confidence interval.

**Unit-4: separation techniques****12 hours**

1. Solvent Extraction: Introduction, principle, techniques, factors affecting solvent extraction, Batch extraction, continuous extraction and counter current extraction. Synergism. Application-Determination of Iron (III).
2. Ion Exchange method: Introduction, action of ion exchange resins, applications.

**UNIT-5: Analysis of water****10hours**

Determination of dissolved solids, total hardness of water, turbidity, alkalinity, Dissolved oxygen, COD, determination of chloride using Mohr's method.

**III. References**

1. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West and Douglas A. Skoog, Ninth edition, Cengage.
2. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug, Seventh edition, Wiley.
3. Quantitative analysis by R. A. Day Jr. and A. L. Underwood, Sixth edition, Pearson.
4. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
5. Text book of Environmental Chemistry and Pollution Control by S.S. Dara and D. D. Mishra, Revised edition, S Chand & Co Ltd.



## **Course6-B: Analytical methods in chemistry-1-PRACTICALSYLLABUS**

### **IV. Learning Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Estimate Iron(II) using standard Potassium dichromate solution
2. Learn the procedure for the estimation of total hardness of water
3. Demonstrate the determination of chloride using Mohr's method
4. Acquire skills in the operation and calibration of pH meter
5. Perform the strong acid vs strong base titration using pH meter

### **V.**

**(Laboratory)Syllabus:(30hrs)**

### **Practical**

(Max.50 Marks)

1. Estimation of Iron(II) using standard Potassium dichromate solution (using DPA indicator)
2. Estimation of total hardness of water using EDTA
3. Determination of chloride ion by Mohr's method
4. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
5. Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid, (ii) Ammonium chloride-ammonium hydroxide.
6. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
7. Determination of dissociation constant of a weak acid.

### **VI. Lab References:**

1. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

## Course 7-B: Analytical Methods in Chemistry-2

### **Unit-1: Chromatography-Introduction and classification**

Principle, Classification of chromatographic methods, Nature of adsorbents, eluents, R<sub>f</sub> values, factors affecting R<sub>f</sub> values.

### **UNIT-2: TLC and paper chromatography** **12 hours**

1. Thin layer chromatography: Principle, Experimental procedure, preparation of plates, adsorbents and solvents, development of chromatogram, detection of spots, applications and advantages.
2. Paper Chromatography: Principle, Experimental procedure, choice of paper and solvents, various modes of development- ascending, descending, radial and two dimensional, applications.

### **UNIT-3: Column chromatography** **12 hours**

1. Column chromatography: Principle, classification, Experimental procedure, stationary and mobile phases, development of the Chromatogram, applications.
2. HPLC: Basic principles, instrumentation –block diagram and applications.

### **UNIT-4: Spectrophotometry** **8 hours**

Principle, Instrumentation: Single beam and double beam spectrometer, Beer- Lambert's law- Derivation and deviations from Beer-Lambert's law, applications of Beer- Lambert's law-Quantitative determination of Fe<sup>+2</sup>, Mn<sup>+2</sup> and Pb<sup>+2</sup>.

### **UNIT-5: Atomic spectroscopy** **8 hours**

Types, atomizer, atomic absorption and emission and applications.

## **II. References**

1. Fundamental so Analytical Chemistry by F.James Holler, Stanley R Crouch, Donald M. West and Douglas A. Skoog, Ninth edition, Cengage.
2. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug, Seventh edition, Wiley.
3. Quantitative analysis by R.A. Day Jr. and A.L. Underwood, Sixth edition, Pearson.
4. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition/ Pearson.

## **Course7-B: Analytical Methods in Chemistry-2- PRACTICAL SYLLABUS**

### **V. Learning Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Perform the separation of a given dye mixture using TLC
2. Learn the preparation of TLC plates
3. Demonstrate the separation of mixture of amino acids using paper chromatography
4. Acquire skills in using column chromatography for the separation of dye mixture

### **VI. Practical (Laboratory) Syllabus: (30hrs) (Max.50Marks)**

1. Separation of a given dye mixture (methyl orange and methylene blue) using TLC (using alumina as adsorbent).
2. Separation of mixture of methyl orange and methylene blue by column chromatography.
3. Separation of given mixture of amino acids (glycine and phenyl alanine) using ascending paper chromatography.
4. Separation of food dyes using Column Chromatography
5. Separation of triglycerides using TLC
6. Verification of Beer Lambert's law. (Using potassium permanganate solution) using colorimeter /spectrophotometer.

### **VII. Lab References:**

1. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
1. Vogel A. I. Practical Organic Chemistry, Longman Group Ltd.
2. Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley- Eastern.
3. Ahluwalia V. K. and Aggarwal R. Comprehensive Practical Organic Chemistry, University press.
4. Mann F.Gand Saunders B.C, Practical Organic Chemistry, Pearson Education.

## Course6-C: Industrial Chemistry-1

### I. Syllabus :

#### **Unit-1: Fertilizers** **10 hours**

A brief introduction to industrial chemistry  
Different types of fertilizers. Manufacture of the following fertilizers: Urea, Ammonium nitrate, Calcium ammonium nitrate, Ammonium phosphates; Polyphosphate, Superphosphate, Compound and mixed fertilizers.

#### **Unit-2: Silicates** **10hours**

1. **Ceramics:** Important clays and Felds par. Ceramics-types, uses and manufacture. Hightechnology ceramics and their applications.
2. **Cements:** Classification of cement, ingredients and their role, Manufacture of cement andthe setting process, quick setting cements.

#### **Unit-3: Surface Coatings** **12 hours**

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, modified oils, Pigments, toners and lake pigments, fillers, thinners, enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Water and Oil paints.

#### **Unit-4: Sugar Chemistry** **08 hours**

Introduction–Manufacture and recovery of cane sugar from molasses, manufacture of sucrosefrom beat root, testing and estimation of sucrose.

#### **Unit-5: Paper Industry** **10 hours**

**Pulp and Paper**-Introduction, Manufacture of pulp, sulphate or Kraft pulp, soda pulp, sulphitepulp, rag pulp, beating, refining, filling, sizing and colouring of pulp, manufacture of paper.

### II. References:

1. E.Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd.UK
2. J.A.Kent: Riegel's *Hand book of Industrial Chemistry*, CBS Publishers, New Delhi.
3. P.C.Jain, M.Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
4. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications,New Delhi.
5. B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut
6. O. P. Vermani, A. K. Narula: *Industrial Chemistry*, Galgotia Publications Pvt. Ltd., NewDelhi.

## **Course6 C: Industrial Chemistry-1- PRACTICAL SYLLABUS**

### **III. Lab work-Skills Outcomes:**

On successful completion of this practical course, student shall be able to:

1. Determine free acidity in ammonium sulphate fertilizer.
2. Learn the procedure for the Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Demonstrate skills on Estimation of phosphoric acid in superphosphate fertilizer.
4. Acquire skills in using colorimetry for the estimation of sucrose.

#### **Practical(Laboratory)Syllabus:(30hrs)**

(Max.50 Marks)

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Estimation of sucrose by colorimetry.

#### **VI: Lab References**

1. Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
2. Text book on Experiments and Calculations in Engineering Chemistry, S.S.Dara, S.Chand.
3. R.Gopalan, D.Venkappayya, S.Nagarajan: Engineering Chemistry, Vikas Publications.
4. B.K.Sharma: Engineering Chemistry, Goel Publishing House, Meerut

## Course7-C: Industrial Chemistry-2

### **Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Identify the importance of industrial waste management.
2. Acquire a critical knowledge on the preparation and applications of organic polymers.
3. Demonstrate the analysis of water quality parameters.
4. Explain the sources of air pollution.

**II. Syllabus :** (*Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.*)

### **Unit-1: Organic Polymers-1**

**10 hours**

Basic definitions, degree of polymerization, classification of polymers- Natural and Synthetic polymers, Organic and Inorganic polymers, Thermoplastic and Thermo setting polymers, Plastics, Elastomers, Fibers and Resins, Linear, Branched and Cross- Linked polymers.

### **Unit-2: Organic Polymers-2**

**10 hours**

Addition polymers and Condensation polymers, mechanism of polymerization- Free radical, ionic and Zeigler-Natta polymerization. Industrial manufacturing and applications of following polymers, Polystyrene, Poly acrylonitrile, Poly methacrylate, Poly methyl-methacrylate.

### **Unit-3: Air Pollution**

**8 hours**

Sources of air pollution, acid rain, photochemical smog, Greenhouse effect, Formation and depletion of ozone, sources and effects of various gaseous pollutants: NO<sub>x</sub>, SO<sub>x</sub>, SPM, CO, hydrocarbons, controlling methods of air pollution.

### **Unit-4: Analysis of water**

**10hours**

Determination of total hardness of water, Dissolved oxygen, BOD, COD, total dissolved solids, turbidity, alkalinity, determination of chloride using Mohr's method.

## Unit-5: Industrial Waste Management

12hours

Waste water treatment - primary, secondary & tertiary treatment. (All treatment methods in detail). Characteristics of solid wastes, methods of solid waste treatment and disposal, microbiology involved in solid waste disposal, methods of solid waste disposal- composting, sanitary landfilling- economic, aesthetic and environmental problems.

### III. References:

1. E.Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK
2. J.A.Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
3. P.C.Jain, M.Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
4. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
5. B.K.Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut
6. O. P. Vermani, A. K. Narula: *Industrial Chemistry*, Galgotia Publications Pvt. Ltd., New Delhi.
7. A.K.De, *Environmental Chemistry*: New Age International Pvt, Ltd, New Delhi.
8. C.k.Varshney: *Water Pollution and Management*, Wiley Eastern Limited, Chennai.
9. S.S. Dara and D.D. Mishra: *Textbook of Environmental Chemistry and Pollution Control*, Revised edition, S.C.Hand & Co Ltd.

## **Course7-C: Industrial Chemistry-2-PRACTICAL SYLLABUS**

**Practical (Laboratory) Syllabus:(30hrs)**

(Max.50 Marks)

1. Determination of Hardness of water by EDTA titration.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Determination of chloride using Mohr's method.
5. Determination of pH, turbidity and total solids in water sample.
6. Determination of  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$  in soil sample by flame photometry.
7. Determination of Ph in soil samples using pH metry.

### **IV. Lab References:**

1. Textbook of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.
2. Textbook on Experiments and Calculations in Engineering Chemistry, S.S.Dara, S.Chand.



**A.S.D. GOVERNMENT DEGREE COLLEGE FOR WOMEN (A), KAKINADA**  
**DEPARTMENT OF CHEMISTRY**  
**THIRD YEAR, SEMESTER- V**  
**Paper 6 - D (ENVIRONMENTAL CHEMISTRY) 60 h (4 h / w)**  
**Course6-D: Environmental Chemistry**

**II Syllabus :**

**UNIT-I: Introduction**

**10 h**

Environment Definition – Concept of Environmental chemistry- Scope and importance of environment in nowadays – Nomenclature of environmental chemistry – Segments of environment– Effects of human activities on environment – Natural resources–Renewable Resources–Solar and biomass energy and Nonrenewable resources – Thermal power and atomic energy – Reactions of atmospheric oxygen and Hydro logical cycle.

**UNIT-II: Air Pollution**

**10 h**

Definition – Sources of air pollution – Classification of air pollution – Ambient air quality standards- Climate change – Global warming – Pollution from combustion systems- Acid rain – Photochemical smog – Greenhouse effect – Formation and depletion of ozone – Bhopal gas disaster–Instrumental techniques to monitor pollution – Controlling methods of air pollution.

**UNIT-III: Water pollution**

**10 h**

Unique physical and chemical properties of water – Water quality standards and parameters – Turbidity- pH Dissolved oxygen – BOD, COD, Suspended solids, total dissolved solids, alkalinity– Hardness of water–Methods to convert temporary hard water in to soft water – Methods to convert permanent hard water into soft water – eutrophication and its effects – Industrial waste water treatment.

**UNIT-IV: Chemical Toxicology**

**10 h**

Toxic chemicals in the environment – effects of toxic chemicals – cyanide and its toxic effects – pesticides and its biochemical effects – toxicity of lead, mercury, arsenic and cadmium- Solid waste management.

## **UNIT-V: Ecosystem and biodiversity**

**10 h**

### **Ecosystem**

Concepts–structure–Functions and types of ecosystem–Abiotic and biotic components – Energy flow and Energy dynamics of ecosystem– Food chains – Food web– Tropic levels– Biogeochemical cycles (carbon, nitrogen and phosphorus)

### **Biodiversity**

Definition – level and types of biodiversity – concept- significance – magnitude and distribution of biodiversity–trends-bio geographical classification of India–biodiversity at national, global and regional level.

### **III. List of Reference books:**

1. Fundamentals of ecology by M.C.Dash
2. A Text book of Environmental chemistry by W. Moore and F.A. Moore
3. Environmental Chemistry by Samir k.Banerji
4. Water pollution, Lalude, MC Graw Hill
5. Environmental Chemistry, Anil Kumar De, Wiley Eastern ltd.
6. Environmental analysis, SM Khopkar ( IIT Bombay )
7. Environmental Chemistry by BK Sharma & H Kaur, Goel publishing house.
8. Fundamentals of Environmental Chemistry, Manahan, Stanley. E
9. Applications of Environmental Chemistry, Eugene R. Wiener

### **Course 6-D: Environmental Chemistry – Practical syllabus**

**IV. Practical (Laboratory) Syllabus: (30 h) (Max.50 M).**

1. Identification of various equipment in the laboratory.
2. Determination of carbonate and bicarbonate in water samples by double titration method.
3. Determination of hardness of water using EDTA
  - a) Permanent hardness
  - b) Temporary hardness
4. Determination of Chlorides in water samples by Mohr's method.
5. Determination of pH, turbidity and total solids in water sample.
6. Determination of  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$  in soil sample by flame photometry.
7. Determination of PH in soil samples using pH metry.

**V. List of Reference books:**

1. A Text Book of Quantitative Inorganic Analysis (3<sup>rd</sup> Edition)–A.I.Vogel
2. Water pollution, Lalude, MC Graw Hill
3. Environmental analysis, SM Khopkar ( IIT Bombay )
4. Web related references suggested by teacher.

**A.S.D. GOVERNMENT DEGREE COLLEGE FOR WOMEN (A), KAKINADA**  
**DEPARTMENT OF CHEMISTRY**  
**THIRD YEAR, SEMESTER- V**  
**Paper 7 - D (GREEN CHEMISTRY AND NANOTECHNOLOGY) 60 h (4 h / w)**

**UNIT-I Green Chemistry: Part- I**

10 h

Introduction-Definition of green Chemistry, Need for green chemistry, Goals 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). Organic reactions by Sonication method: apparatus required and examples of sonochemical reactions (Heck, Hunsdiecker and Wittig reactions).

**UNIT- II Green Chemistry: Part- II**

10 h

**A) Selection of solvent:**

i) Aqueous phase reactions  
ii) Reactions in ionic liquids, Heck reaction, Suzuki reactions, epoxidation. Iii) Solid supported synthesis

**B) Supercritical CO<sub>2</sub>:** Preparation, properties and applications, (decaffeination, drycleaning)

**C) Green energy and sustainability.**

**UNIT-III Microwave and Ultrasound assisted green synthesis: 10 h**

Apparatus required, examples of MAOS (synthesis of fused anthraquinones, Leuckart reductive amination of ketones) - Advantages and disadvantages of MAOS. Aldol condensation – Cannizzaro reaction- Diels-Alder reactions-Strecker's synthesis

**UNIT-IV Green catalysis and Green synthesis 10 hrs.**

Heterogeneous catalysis, use of zeolites, silica, alumina, supported catalysis - bio catalysis: Enzymes, microbes Phase transfer catalysis (micellar /surfactant)

1. Green synthesis of the following compounds: adipic acid, catechol, disodium menudo acetate(alternative Strecker's synthesis)
2. Microwave assisted reaction in water –Hoffmann elimination – methyl benzoate to benzoic acid – oxidation of toluene and alcohols–microwave assisted reactions in organic solvents. Diels-Alder reactions and decarboxylation reaction.
3. Ultrasound assisted reactions–sonochemical Simmons–Smith reaction (ultrasonic alternative to iodine)

## **UNIT – V Nanotechnology in Green chemistry**

10 h

Basic concepts of Nano science and Nanotechnology – Bottom-up approach and Top down approaches with examples – Synthesis of Nano materials – Classification of Nanomaterial – Properties and Application of Nanomaterial. Chemical and Physical properties of Nanoparticles – Physical synthesis of nanoparticles – Inert gas condensation - aerosol method - Chemical Synthesis of nanoparticles – precipitation and co-precipitation method, sol-gel method.

### **III. Reference books:**

1. Green Chemistry Theory and Practical. P.T.Anatas and J.C. Warner
2. Green Chemistry V.K. Ahluwalia Narosa, New Delhi.
3. Real world cases in Green Chemistry M.C. Cann and M.E. Connelly
4. Green Chemistry: Introductory Text M.Lancaster: Royal Society of Chemistry (London)
5. Principles and practice of heterogeneous catalysis, Thomas J.M., Thomas M.J., John Wiley
6. Green Chemistry: Environmental friendly alternatives R S Sanghli and M.M Srivastava, Narosa Publications
7. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press (2008).
8. Green Processes for Nanotechnology: From Inorganic to Bioinspired Nanomaterials, Vladimir A. Basiuk, Elena V. Basiuk Springer (2015)

### **Practical (Laboratory) Syllabus: (30 hrs.) (Max.50 Marks).**

9. Identification of various equipment in the laboratory.
10. Acetylation of 1<sup>o</sup> amine by green method: Preparation of acetanilide
11. Rearrangement reaction in green conditions: Benzil - Benzilic acid rearrangement
12. Radical coupling reaction: Preparation of 1,1-bis -2-naphthol
13. Green oxidation reaction: Synthesis of adipic acid
14. Preparation and characterization of biodiesel from vegetable oil/ waste cooking oil
15. Preparation and characterization of Nanoparticles of gold using tea leaves.
16. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
17. Photo reduction of Benzophenone to Benzopinacol in the presence of sunlight.