



## **ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION**

(A Statutory body of the Government of Andhra Pradesh)

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Andhra Pradesh

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### **REVISED SYLLABUS OF B.Sc. (Chemistry) UNDER CBCS FRAMEWORK WITH EFFECT FROM 2023 -24**

#### **PROGRAMME: FOUR-YEAR UG HONOURS PROGRAMME IN SINGLE MAJOR CHEMISTRY**

*(With Learning Outcomes, Unit-wise Syllabus, References, Co-curricular Activities &  
Model Q.P.)*

Courses of 1, 2, 3 & 4 Semesters)  
(To be Implemented from 2023-24 Academic Year)

A.P.STATE COUNCIL OF HIGHER EDUCATION  
SEMESTER-WISE REVISED UGSYLLABUS UNDER CBCS FROM 2023-24  
**FOUR-YEAR UG HONOURS PROGRAMME IN SINGLE MAJOR**  
DOMAIN SUBJECT: CHEMISTRY  
COURSES FOR SEMESTERS II, III & IV.  
(SYLLABUS WITH LEARNING OUTCOMES, REFERENCE BOOKS & CO-CURRICULAR  
ACTIVITIES)

Semester	Major/ Minor	Course No	Title of the course	Theory - No of hours per week	Theory - No of credits	Practical- No of hours per week	Practical- No of credits	Total No of credits
<b>II</b>	<b>Minor &amp; major</b>	<b>I</b>	General & Inorganic Chemistry	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
	<b>Major</b>	<b>II</b>	Inorganic Chemistry-I	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
<b>III</b>	<b>Minor &amp; major</b>	<b>III</b>	Fundamentals in Organic Chemistry	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
	<b>Major</b>	<b>IV</b>	Organic Chemistry (Halogen & Oxygen Organic Compounds)	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
	<b>Major</b>	<b>V</b>	Physical Chemistry-I ( Solutions and Electrochemistry)	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
	<b>Major</b>	<b>VI</b>	Inorganic & Physical Chemistry	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
<b>IV</b>	<b>Minor &amp; major</b>	<b>VII</b>	Physical Chemistry-II (States of Matter, Phase Rule & surface Chemistry)	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
	<b>Minor &amp; major</b>	<b>VIII</b>	General & Physical Chemistry	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
	<b>Major</b>	<b>IX</b>	Nitrogen containing Organic Compounds & Spectroscopy.	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>

**A.P.STATE COUNCIL OF HIGHER EDUCATION  
REVISED UG SYLLABUS UNDER CBCS FROM 2023-24  
SEMESTER-II COURSE -I [MAJOR AND MINOR]**

**GENERAL AND INORGANIC CHEMISTRY (45hrs: 3hrs/week)**

**I. Course Outcomes:** At the end of the course the student will be able to-

1. Understand the structure of atom and the arrangement of elements in the periodic table.
2. Understand the nature and properties of ionic compounds.
3. Identify the structure of a given inorganic compound.
4. Explain the existence of special types of compounds through weak chemical forces.
5. Define acids and bases and predict the nature of salts.

**II. Syllabus:**

**Unit I: Atomic Structure and Periodic table (9 h)**

Electronic configuration: Bohr theory, dual nature of electrons, Heisenberg uncertainty principle, the Schrodinger equation, significance of wave functions, normalization of wave function, radial and angular wave functions, Pauli's exclusion principle, Hund's rule, sequence of energy levels (Aufbau principle).

Periodicity: periodic law and arrangement of elements in the periodic table, IUPAC nomenclature and group number, horizontal, vertical, and diagonal relationships in the periodic table. 1.3 General properties of atoms: size of atoms and ions-atomic radii, ionic radii, covalent radii; trend in ionic radii, ionization potential, electron affinity; electronegativity - Pauling, Mulliken-Jaffe, Allred-Rochow definitions; oxidation states and variable valency; isoelectronic relationship; inert-pair effect;

**UNIT 2: Ionic bond (9 h)**

Properties of ionic compounds, factors favouring the formation of ionic compounds- ionization potential, electron affinity, and electronegativity. Lattice energy: definition, factors affecting lattice energy, Born-Haber cycle-enthalpy of formation of ionic compound and stability. Stability of ionic compounds in terms of  $\Delta H_f$  and  $U_o$ . Solubility and thermal stability of ionic compounds. Covalent character in ionic compounds-polarization and Fajan's rules; effects of polarization-solubility, melting points, and thermal stability of typical ionic compounds.

**UNIT 3: The Covalent Bond (9 h)**

Valence Bond theory-arrangement of electrons in molecules, hybridization of atomic orbitals and geometry of molecules-BeCl<sub>2</sub>, BF<sub>3</sub>, CH<sub>4</sub>, PCl<sub>5</sub>, SF<sub>6</sub>- VSEPR model-effect of bonding and nonbonding electrons on the structure of molecules, effect of electronegativity, isoelectronic principle, illustration of structures by VESPR model-NH<sub>3</sub>, H<sub>2</sub>O, SF<sub>4</sub>, ICl<sub>4</sub><sup>-</sup>, ICl<sub>2</sub><sup>-</sup>, XeF<sub>4</sub>, XeF<sub>6</sub>

Molecular orbital theory -LCAO method, construction of M.O. diagrams for homo-nuclear and hetero-nuclear diatomic molecules (N<sub>2</sub>, O<sub>2</sub>, CO and NO)

#### **UNIT 4: Metallic and Weak Bonds (9 h)**

The Metallic bond: metallic properties, free electron theory, Valence Bond Theory, band theory of metals. Explanation of conductors, semiconductors and insulators.

Weak bonds: hydrogen bonding-intra- and intermolecular hydrogen bonding, influence on the physical properties of molecules, comparison of hydrogen bond strength and properties of hydrogen bonded N, O and F compounds; associated molecules-ethanol and acetic acid; Vanderwaals forces, ion dipole-dipole interactions.

#### **UNIT 5: Acids and Bases (9 h)**

Theories of acids and bases: Arrhenius theory, Bronsted-Lowry theory, Lewis theory, the solvent system, Nonaqueous solvents: classification-protonic and aprotic solvents, liquid ammonia as solvent-solutions of alkali and alkaline earth metals in ammonia.

Types of chemical reactions: acid-base, oxidation-reduction, calculation of oxidation number. Definition of pH, pK<sub>a</sub>, pK<sub>b</sub>. Types of salts, Salt hydrolysis. Pearson's concept, HSAB principle & its importance, bonding in Hard-Hard and Soft-Soft combinations.

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

1. J. D. Lee, Concise Inorganic Chemistry, 5<sup>th</sup> ed., Blackwell Science, London, 1996.
2. . B. R. Puri, L. R. Sharma, K. C. Kalia, Principles of Inorganic Chemistry, Shoban Lal Nagin Chand and Co., 1996.
3. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3<sup>rd</sup> ed., W. H. Freeman and Co, London,

**LABORATORY COURSE -I ( 30hrs - 2 h / w)**  
**Practical- I Qualitative Analysis of SIMPLE SALT**

Qualitative inorganic analysis (Minimum of Six simple salts should be analysed) 50 M

**IV. Course outcomes:**

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

1. Understand the basic concepts of qualitative analysis of inorganic simple salt.
2. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
3. Apply the concepts of common ion effect, solubility product and concepts related to qualitative analysis

**V. Laboratory course syllabus:**

**Analysis of SIMPLE SALT 50 M**

Analysis of simple salt containing ONE anion and ONE cation from the following:

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

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

**VI. Co-curricular activities and Assessment Methods**

1. Continuous Evaluation: Monitoring the progress of student's learning.
2. Class Tests, Work sheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality
4. Semester-End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**VII. Reference books:**

1. Vogel's Qualitative Inorganic Analysis, Seventh edition, Pearson.

**VIII. Suggested Question Paper Pattern (Theory): Max. Marks: 75 (Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks

(At least 1 question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**

**REVISED UGSYLLABUS UNDER CBCS FROM 2023-24**

**SEMESTER-II COURSE -II [MAJOR ONLY]**

## **Inorganic Chemistry (45hrs: 3hrs/week)**

### **I. 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 concepts of d-block elements
3. Distinguish lanthanides and actinides.
4. Describe the importance of radioactivity.

### **II. Syllabus:**

#### **UNIT –I Chemistry of p-block elements – I 9 h**

Group 13: Preparation & structure of Diborane, Borazine and  $(BN)_x$

Group 14: Preparation, classification and uses of silicones and Silanes.

Group 15: Preparation & structure of Phosphonitrilic Chloride  $P_3N_3Cl_6$

#### **Unit II Chemistry of p-block elements – II 9 h**

Group 16: Classification of Oxides, structures of oxides and Oxoacids of Sulphur

Group 17: Preparation and Structures of Interhalogen compounds. Pseudohalogens,

#### **UNIT-III Chemistry of d-block elements: 9 h**

Characteristics of d-block elements with special reference to electronic configuration, variable valence, colour, magnetic properties, catalytic properties and ability to form complexes. Stability of various oxidation states of 3d series-Latimer diagrams.

#### **UNIT-IV Chemistry of f-block elements: 9 h**

Chemistry of lanthanides - electronic configuration, oxidation states, lanthanide contraction, consequences of lanthanide contraction, colour, magnetic properties. Separation of lanthanides by ion exchange method.

Chemistry of actinides - electronic configuration, oxidation states, actinide contraction, comparison of lanthanides and actinides.

#### **Unit – V Radioactivity 9 h**

Definition, Isotopes, n/p ratio, binding energy, types of radioactivity, Soddy-Fajan's displacement law, Law of Radioactivity, Radioactive decay series, Nuclear Reactions-fission and fusion, Applications of radioactivity.

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

1. Basic Inorganic Chemistry by Cotton and Wilkinson
2. Advance Inorganic chemistry vol-I by Satya Prakash
3. Inorganic chemistry by Puri and Sharma
4. Concise Inorganic Chemistry by J D Lee
5. Nuclear Chemistry by Maheshwar Sharon, 2009

**Laboratory Course–II                    30hrs(2h/w)**  
**Practical-II Inorganic Preparations (50 Marks) IV.**

**Course outcomes:**

At the end of the course, the student will be able to:

1. Understand the basic concepts of inorganic preparations.
2. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
3. Apply the properties of various elements for the preparation of inorganic compounds.

**Syllabus:**

**Preparation of Inorganic compounds:**

1. Crystallization of compounds and determination of melting point.
2. Preparation of Cuprous chloride.
3. Preparation of Potash Alum.
4. Preparation of Chrome Alum.
5. Preparation of Ferrous oxalate
6. Preparation of Ferrous ammonium sulphate.

**Co-curricular activities and Assessment Methods**

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality
4. Semester-End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**Reference books:**

1. Vogel's Quantitative Inorganic Analysis, Seventh edition, Pearson.

**VIII.Suggested Question Paper Pattern(Theory): Max.Marks: 75(Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks

(At least 1question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks

(At least 1question should be given from each Unit

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**REVISED UGSYLLABUS UNDER CBCS FROM 2023-24**  
**SEMESTER-III COURSE -III [Major and Minor]**

**FUNDAMENTALS IN ORGANIC CHEMISTRY (45hrs: 3hrs/week)**

**I. Course outcomes:**

**At the end of semester the student will be able to**

1. Understand and explain the differential behaviour of organic compounds based on fundamental concepts learnt.
2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
3. Learn and identify many organic reaction mechanisms .
4. Correlate and describe the stereo-chemical properties of organic compounds and reactions.

**II. Syllabus:**

**Unit 1. Structural theory in Organic Chemistry (9 h)**

Types of bond fission and organic reagents (Electrophilic, Nucleophilic, and free radical reagents). Reaction intermediates – Carbocations, carbanions & free radicals. Bond polarization: Factors influencing the polarization of covalent bonds, inductive effect - Application of inductive effect (a) Basicity of amines (b) Acidity of carboxylic acids (c) Stability of carbonium ions. Resonance or Mesomeric effect, application to (a) acidity of phenol, and (b) acidity of carboxylic acids. Hyper conjugation and its application to stability of carbonium ions, Free radicals and alkenes.

**Unit II Saturated Hydrocarbons (Alkanes and Cycloalkanes) 9 h**

General methods of preparation of alkanes- Wurtz and WurtzFittig reaction, Corey House synthesis, physical and chemical properties of alkanes, 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 monosubstituted cyclohexane.

**UNIT-III Unsaturated Hydrocarbons (Alkenes and Alkynes) 9 h**

General methods of preparation, physical and chemical properties, Saytzeff and Hoffmann eliminations (with mechanism), Electrophilic Additions, ( $H_2$ , HX) mechanism (Markownikoff/ Antimarkownikoff addition) with suitable examples-syn and anti-addition; addition of  $X_2$ , HX. Oxymercuration demercuration, 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-IV Benzene and its reactivity (9 h)**

Structure of Benzene – Preparation - polymerisation of acetylene and decarboxylation- Properties -mechanism of electrophilic aromatic substitution of Friedel- Craft's alkylation and acylation. halogenation and nitration,

### **UNIT-V Orientation of aromatic substitution (9 h)**

Concept of aromaticity, Huckel's rule - application to Benzenoid (Benzene, Naphthalene) and Non - Benzenoid compounds (cyclopropenylcation, cyclopentadienyl anion and tropylium cation) 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, nitrile, carbonyl and sulphonic acid groups (iii) Halogens.

#### **III. List of Reference Books**

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Guide book to Mechanism in Organic Chemistry by Peter Sykes 6<sup>th</sup> edition, 1985.

**Laboratory Course -3**                      **30hrs (2 h / w)**  
**Organic Qualitative analysis ( 50 M )**

**IV. Course outcomes:**

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

1. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
2. Determine melting and boiling points of organic compounds
3. Understand the application of concepts of different organic reactions studied in theory part of organic chemistry

**V. Syllabus:**

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.

**VI. Co-curricular activities and Assessment Methods**

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality
4. Semester-End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**VII. Reference books:**

Vogel A.I .Practical Organic Chemistry, Longman Group Ltd.

- 1) Bansal R.K. Laboratory Manual of Organic Chemistry, Wiley-Eastern.
- 2) Ahluwalia V. K. and Agarwal R. Comprehensive Practical Organic Chemistry, University press.

**VIII.Suggested Question Paper Pattern(Theory): Max.Marks: 75(Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks

(At least 1question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks

(At least 1question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**REVISED UGSYLLABUS UNDER CBCS FROM 2023-24 SEMESTER-**  
**III COURSE -IV [MAJOR ]**  
**ORGANIC CHEMISTRY**  
**(Halogen and Oxygen containing organic compounds)(45hrs: 3hrs/week)**

**I. Course outcomes:**

At the end of the course, the student will be able to:

1. Understand the concept of  $S_N1$  and  $S_N2$  and  $S_Ni$  mechanisms.
2. Describe the reactivity of alcohols and phenols.
3. Achieve the skills required to propose various mechanisms
4. Apply the concepts for synthesising various oxygen containing organic compounds
5. Interconvert the monosaccharides.

**II. Syllabus:**

**Unit – I Halogen compounds ( 9 h )**

**Alkyl halides:** Preparation of alkyl halides from i) alkanes, ii) alkenes and iii) alcohols. Properties - nucleophilic substitution reactions –  $S_N1$  and  $S_N2$  and  $S_Ni$  mechanisms with energy profile diagrams, stereo chemical aspects and effect of solvent. Williamson's synthesis.

**Aryl halides:** Preparation i) from phenols ii) Sandmeyer's reaction, nucleophilic aromatic substitution (Benzyne mechanism); relative reactivity of alkyl, allyl, vinyl and benzyl, aryl halides towards nucleophilic substitution reactions.

**Unit II Alcohols and Phenols ( 9 h )**

**Alcohols:** Preparation of  $1^\circ, 2^\circ, 3^\circ$  alcohols from Grignard's reagent, Bouveault–Blanc Reduction; Chemical properties – substitution of –OH by using  $PCl_5, PCl_3, PBr_3, SOCl_2$  and with  $HX / ZnCl_2$ , Oxidation of alcohols with PCC, PDC; Oxidation of diols by  $HIO_4$  and  $Pb(OAc)_4$ , Pinacol Pinacolone arrangement with mechanism, relative reactivity of  $1^\circ, 2^\circ, 3^\circ$  alcohols.

**Phenols :** Preparation from diazonium salt and Cumene. Reactions and mechanism – Reimer–Tiemann, Kolbe–Schmitt Reactions, Fries and Claisen rearrangements.

**Unit III Carbonyl Compounds ( 9 h )**

Preparation from – Acid chlorides, 1,3-dithiane and nitriles; Structure and reactivity of carbonyl group, Nucleophilic addition reactions with HCN,  $NaHSO_3$  and alcohols. additional elimination reactions with hydroxylamine, hydrazine, phenyl hydrazine, 2,4DNP,

semicarbazide. Oxidations and reductions (Clemmensen's, Wolf-Kishner's, with  $\text{LiAlH}_4$  &  $\text{NaBH}_4$ ).

**Reaction & Mechanism-** Aldol condensation, Cannizzaro reaction, Perkin reaction, Benzoin condensation, Claisen-Schmidt reaction, Haloform reaction

#### **Unit-IV Carboxylic acid and Active methylene Compounds (9h)**

**Carboxylic Acids:** Preparation from Grignard reagent and hydrolysis of nitriles, Reactions of monocarboxylic acids- Reactions involving -H, -OH and -COOH groups, formation of salts, esters, acid chlorides, amides and anhydrides. Degradation of carboxylic acids by Hunsdiecker's reaction, decarboxylation by Schmidt reaction, Arndt-Eistert synthesis, halogenation by Hell- Volhard- Zelinsky reaction. Mechanisms of acidic and alkaline hydrolysis of esters, Reformatsky reactions, Curtius rearrangement.

**Active methylene compounds:** Keto-enol tautomerism, preparation of Aceto Acetic Ester(AAE) by Claisen condensation with mechanism, synthetic applications of AAE in the preparation of mono carboxylic acids, di carboxylic acids,  $\alpha,\beta$ -unsaturated acids and heterocyclic compounds.

#### **Unit V : Carbohydrates ( 9 h )**

Classification and their biological importance, Monosaccharides: Structural elucidation of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides- Haworth structure of maltose, lactose and sucrose.

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- 2) Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
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**LABORATORY COURSE – IV**  
**Organic preparations( 30hrs - 2h/w)**

**IV. Course outcomes:**

On the completion of the course, the student will be able to do the following:

1. How to use glassware, equipment and chemicals and follow experimental procedures in the laboratory.
2. How to calculate limiting reagent, theoretical yield, and percent yield.
3. How to perform common laboratory techniques including reflux, distillation, recrystallization, vacuum filtration.
4. How to critically evaluate data collected to determine the identity, purity and percent yield of products and to summarize findings in writing in a clear and concise manner.

**V. Syllabus - Organic preparations (50M)**

- i. Acetylation of  $\beta$ -naphthol, vanillin and salicylic acid by:
  - a) Using conventional method.
  - b) Using green approach
- ii. Preparation of Nerolin

**VI. Co-curricular activities and Assessment Methods;**

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**VIII. Suggested Question Paper Pattern(Theory): Max.Marks: 75(Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks

(At least 1 question should be given from each Unit)

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**SEMESTER-III COURSE - V [MAJOR ONLY]**

**PHYSICAL CHEMISTRY (Solutions & Electro Chemistry) (45hrs: 3hrs/week)**

**I. Course outcomes:**

At the end of the semester the student will be able to

1. Understand the ideal and non ideal behaviour of solutions.
2. Determine the molecular mass of non-volatile solutes.
3. Discuss the basic concepts of Photochemistry.
4. Apply the principles of electrical conductivity.
5. Explain the importance of emf and its applications.

**II. Syllabus:**

**Unit I Solutions (9 h)**

Classification - Miscible, Partially miscible and Immiscible - Raoult's Law - 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.

**Unit II Colligative Properties (9 h)**

Relative lowering of Vapour Pressure, Elevation in boiling point depression in freezing point and Osmotic pressure. Determination of molecular mass of non-volatile solute by Ostwald-Walker method, Cottrell's method, Rast method and Barkeley-Hartley method. Abnormal colligative properties. Van'tHoff factor.

**Unit III – Photochemistry (9h)**

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, chemiluminescence - Photosensitized reactions- energy transfer processes (simple example), quenching, Photo stationary state.

**Unit IV Electrochemistry-I (9 h)**

Conductance, Specific conductance, equivalent conductance and molar conductance - 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 - Onsagar's equation for strong electrolytes (derivation excluded), Application of conductivity measurements- conductometric titrations.

### **Unit V Electrochemistry-II ( 9 h )**

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. Fuelcells – Basic concepts, examples and applications.

### **III. 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) Advanced physical chemistry by Gurudeep Raj
- 7) Principles of physical chemistry by Puri, Sharma and Pathania.

**Laboratory Course –V**  
**Course-V -PHYSICAL CHEMISTRY (30hrs - 2h/w)**

**IV. Course outcomes:**

At the end of the course, the student will be able to:

1. Use of glassware, equipment and chemicals and follow experimental procedures in the laboratory.
2. Understand and apply the concepts of solutions practically.
3. Apply concepts of electrochemistry in experiments.

**V. Syllabus:**

**CST, Conductometric and Potentiometric Titrimetry            50 M**

1. Determination of CST for Phenol-water system.
2. Effect of electrolyte on CST.
3. Conductometric titration - Determination of concentration of HCl solution using standard NaOH solution.
4. Conductometric titration – Determination of concentration of CH<sub>3</sub>COOH Solution using standard NaOH solution.
5. Potentiometric titration-Determination of concentration of HCl using standard NaOH solution.

**VI. Co-curricular activities and Assessment Methods;**

- 1) Continuous Evaluation: Monitoring the progress of student's learning
- 2) Class Tests, Worksheets and Quizzes
- 3) Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality
- 4) Semester-End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**VII. List of reference books:**

- 1) A Text Book of Quantitative Inorganic Analysis(3<sup>rd</sup> Edition) – A.I.Vogel
- 2) Web related references suggested by teacher.

**VIII. Suggested Question Paper Pattern(Theory): Max.Marks: 75(Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks

(At least 1 question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**

**REVISED UGSYLLABUS UNDER CBCS FROM 2023-24**  
**SEMESTER-III COURSE - VI [MAJOR ONLY]**

**Inorganic and Physical Chemistry (45hrs: 3hrs/week)**

**I. Course outcomes:**

At the end of the semester the student will be able to:

- 1) Apply IUPAC nomenclature for Coordination compounds
- 2) Understand the various theories, structure and stereo chemistry of coordination compounds.
- 3) Explain the reaction mechanism in complexes.
- 4) Apply the 18 electron rule.
- 5) Discuss the basic concepts of thermodynamics.

**II. Syllabus;**

**Unit I Coordination Chemistry-I ( 9 h )**

IUPAC nomenclature of Coordination compounds, structural and stereo isomerism in complexes with coordination numbers 4 and 6. Valence Bond

Theory (VBT): Postulates magnetic properties- Inner and outer orbital complexes. Limitations of VBT, CFT- Postulates - Splitting in Octahedral, tetrahedral, tetragonal and square planar fields. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Factors affecting the magnitude of crystal field splitting energy, Spectrochemical series, Tetragonal distortion of octahedral geometry, Jahn-Teller distortion.

**UNIT-II Coordination Chemistry II ( 9 h )**

**1. Inorganic molecular Reaction Mechanism: ( 6 h )**

Introduction to inorganic reaction mechanisms. Concept of reaction pathways, transition state, intermediate and activated complex. Labile and inert complexes, ligand substitution reactions –  $SN_1$  and  $SN_2$ , Substitution reactions in square planar complexes, Trans-effect, theories of trans effect and its applications

**2. Stability of metal complexes: ( 3 h )**

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.

**Unit III Organo metallic compounds ( 9 h )**

Definition and classification of organo metallic Compounds on the basis of bond type, Metal carbonyls: 18 electron rule, electron count of mononuclear, poly nuclear and substituted metal carbonyls of 3d series. General methods of preparation of mono and binuclear carbonyls of 3d series.  $\pi$ -acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

#### **Unit IV Thermodynamics- I ( 9 h )**

Concept of heat( $q$ ), work( $w$ ), internal energy( $U$ ), State function and Path function- statement of first law; enthalpy( $H$ ), relation between heat capacities, calculations of  $q$ ,  $w$ ,  $U$  and  $H$  for reversible, irreversible processes, Joule-Thomson effect- coefficient, Calculation of work for the expansion of perfect gas under isothermal and adiabatic conditions for reversible processes. Temperature dependence of enthalpy of formation- Kirchoff's equation.

#### **Unit V Thermodynamics II ( 9 h )**

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 equation - Criteria for spontaneity.

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

- 1) Concise coordination chemistry by Gopalan and Ramalingam
- 2) Coordination Chemistry by Basalo and Johnson
- 3) Text book of physical chemistry by S Glasstone
- 4) Concise Inorganic Chemistry by J.D.Lee
- 5) Advanced Inorganic Chemistry Vol-I by Satyaprakash, Tuli, Basu and Madan 6)A Text Book of Physical Chemistry by K.L.Kapoor Vol 2, 6<sup>th</sup> edition, 2019.



**REVISED UGSYLLABUS UNDER CBCS FROM 2023-24**  
**SEMESTER-IV COURSE -VII [MAJOR AND MINOR]**

**PHYSICAL CHEMISTRY (States of Matter, Phase Rule & Surface Chemistry)**  
**(45hrs: 3hrs/week)**

**I. Course outcomes:**

At the end of the semester the student will be able to:

1. Explain the difference between solids liquids and gases in terms of intermolecular interactions.
2. Differentiate ideal and real gases.
3. Discuss the basic concepts of two component systems
4. Apply the concepts of adsorption.
5. Understand the basic concepts of crystallography.

**II. Syllabus:**

**Unit I - Gaseous state (9 h )**

Postulates of Kinetic theory of Gases (exclude derivation) – deduction of gas laws from kinetic gas equation-Vander 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.

**Unit II – Liquid State (9 h )**

Physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

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-III - Solid state (9h )**

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

**Unit IV - Phase Rule (9 h )**

The Concept of phase, components, degrees of freedom. 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 V Surface Chemistry ( 9 h )**

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

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

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

- 1) Solid State Chemistry and its applications by Anthony R. West
- 2) Text book of physical chemistry by K L Kapoor Vol.1
- 3) Text book of physical chemistry by S Glasstone
- 4) Advanced physical chemistry by Bahl and Tuli.

### **LABORATORY COURSE –VII ( 30hrs - 2h/w) Course- VII - Organic preparations**

#### **IV. Course outcomes:**

At the end of the course, the student will be able to:

- 1) Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- 2) Apply concepts of surface chemistry in experiments.
- 3) Be familiar with the concepts & practical applications of Surface tension and viscosity of liquids.

#### **V. Physical Chemistry Practical Syllabus:**

1. Determination of surface tension of liquid by drop count method
2. Determination of surface tension of liquid by drop weight method
3. Determination of surface tension of mixture (liquid + detergent) using stalagmometer.
4. Determination of coefficient of viscosity of an organic liquid.
5. Determination of composition of a glycerol in glycerol + water mixture using viscometer.
6. Adsorption of acetic acid on animal charcoal, verification of Freundlich isotherm.

#### **VI. Co-curricular activities and Assessment Methods:**

- 1) Continuous Evaluation: Monitoring the progress of student's learning
- 2) Class Tests, Worksheets and Quizzes
- 3) Presentations, Projects and Assignments and Group Discussions: Enhances

critical thinking skills and personality

- 4) Semester-End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**VII. List of reference books:**

- 1) A Text Book of Quantitative Inorganic Analysis (3<sup>rd</sup> Edition) – A.I. Vogel  
2) Web related references suggested by teacher.

**VIII. Suggested Question Paper Pattern (Theory): Max. Marks: 75 (Time: 3 hrs)**

**SECTION-A ( Total : 5x2 = 10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5 = 25 Marks )**

(Answer any five questions. Each answer carries 5 marks  
(At least 1 question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks  
(At least 1 question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION  
REVISED UG SYLLABUS UNDER CBCS FROM 2023-24  
SEMESTER-IV COURSE - VIII [MAJOR AND MINOR]**

**GENERAL AND PHYSICAL CHEMISTRY (45hrs: 3hrs/week)**

**I. Course outcomes:**

At the end of the semester the student will be able to:

1. Correlate and describe the stereochemical properties of organic compounds.
2. Explain the biological significance of various elements present in the human body.
3. Apply the concepts of ionic equilibrium for the qualitative and quantitative analysis.
4. Determine the order of a chemical reaction.
5. Describe the basic concepts of enzyme catalysis.

**II. Syllabus:**

**UNIT-I Stereo chemistry of carbon compounds ( 9 h )**

Molecular representations - Wedge, Fischer, Newman and Saw-Horse formulae.

Optical isomerism: Optical activity- wave nature of light, plane polarised 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-dibromopentane.

**Unit II Bioinorganic Chemistry ( 9 h )**

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals, Na / K- pump, carbonic anhydrase and carboxy peptidase. 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, Cisplatin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin-transfer of oxygen, Myoglobin-Storage and transfer of iron

**Unit III Ionic equilibrium ( 9 h )**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, Buffer solutions-Henderson's equation. Indicators-theories of acid – base Indicators, selection of Indicators,

Common ion effect Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

**Unit IV Chemical Kinetics-I: ( 9 h )**

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 (similar and different reactants). Half-life of a reaction. General methods for determination of order of a reaction.

### **Unit V Chemical Kinetics-II: ( 9 h 0**

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.

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

- 1)Text book of physical chemistry by S Glasstone
- 2)Concise Inorganic Chemistry by J.D.Lee
- 3) Advanced physical chemistry by Gurudeep Raj
- 4) Advanced physical chemistry by Bahl and Tuli
- 5) Inorganic Chemistry by J.E.Huheey
- 6) Basic Inorganic Chemistry by Cotton and Wilkinson.

### **LABORATORY COURSE –VIII (30hrs - 2h/w) Physical Chemistry - Volumetric Analysis ( 50 M )**

#### **IV. Course outcomes:**

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

1. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
2. Understand and explain the volumetric analysis based on fundamental concepts learnt in ionic equilibria
3. Learn and identify the concepts of a standard solutions, primary and secondary standards
4. Facilitate the learner to make solutions of various molar concentrations.

#### **V. Syllabus:**

##### **Volumetric analysis:**

1. Estimation of sodium hydroxide using standardised HCl solution.
2. Estimation of sodium carbonate and sodium hydroxide present in a mixture.
3. Determination of Fe (II) using  $\text{KMnO}_4$  with oxalic acid as primary standard. (internal indicator method)
4. Determination of Fe (II) using  $\text{KmnO}_4$  with oxalic acid as primary standard. (external indicator method)
5. Estimation of water of crystallization in Mohr's salt by titrating with  $\text{KmnO}_4$

#### **VI. Co-curricular activities and assessment methods :**

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality
4. Semester-End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**VII. List of reference books:**

1. A Text Book of Quantitative Inorganic Analysis(3<sup>rd</sup>Edition) –A.I.Vogel
2. Web related references suggested by teacher.

**VIII.Suggested Question Paper Pattern(Theory): Max.Marks: 75(Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks  
(At least 1question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks  
(At least 1question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION  
REVISED UGSYLLABUS UNDER CBCS FROM 2023-24  
SEMESTER-IV COURSE –IX[ MAJOR ]**

**Nitrogen containing Organic Compounds & Spectroscopy(45hrs: 3hrs/week)**

**I. Course outcomes:**

At the end of the semester the student will be able to:

1. Distinguish primary secondary and tertiary amines and their properties.
2. Describe the preparation and properties of amino acids.
3. Explain the reactivity of nitro hydrocarbons.
4. Discuss heterocyclic compounds with N, O and S.
5. Apply the concepts of UV and IR to ascertain the functional group in an organic compound.

**II. Syllabus:**

### **Unit I Amines: ( 9 h )**

Classification, chirality in amines (pyramidal inversion), preparations – Gabriel synthesis, Hoffmann- Bromamide reaction ( with mechanism), reduction of amides and Schmidt reaction. Distinction between Primary, secondary and tertiary amines using Hinsberg's method and nitrous acid. Discussion of the following reactions with emphasis on the mechanistic pathway: Carbylamine reaction, Hoffmann's exhaustive methylation, Hofmann and Cope elimination.

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

### **UNIT- II Amino acids ( 9 h )**

Definition and 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: 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.

### **UNIT- III Nitro hydrocarbons ( 9h )**

Nomenclature and classification, 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 Micheal addition and reduction.

### **Unit IV Heterocyclic Compounds ( 9 h )**

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 - electrophillic substitution at 2 or 5 position, Halogenation, Nitration and Sulphonation - Diels Alder reaction in furan. Pyridine – synthesis - Aromaticity -Basicity - Comparison with pyrrole-one method of preparation and properties - Reactivity towards Nucleophilic substitution reaction.

### **Unit V UV-Visible & IR Spectroscopy ( 9 h )**

Selection rules for electronic spectra, types of electronic transitions in molecules, concept of chromophore and auxochrome, effect of conjugation- Woodward Fischer rules for calculating  $\lambda_{\text{max}}$  of conjugated dienes and  $\lambda_{\text{max}}$  unsaturated compounds. Infrared spectroscopy and types of molecular vibrations and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intra molecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on  $>C=O$  stretching absorptions).

### III. List of Reference Books

- 1) A Text Book of Organic Chemistry by Bahl and Arunbahl
- 2) A Text Book 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) Spectrometric Identification of Organic Compounds by Robert M Silverstein, Francis X Webster

### Laboratory Course –IX ( 30hrs-2h/w )

#### Course-IX

#### Organic preparations and IR Spectral Analysis

#### IV. Course outcomes:

On completion of the course, the student will be able to:

- 1) Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
- 2) Calculate limiting reagent, theoretical yield, and percent yield
- 3) Engage in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately
- 4) Dispose of chemicals in a safe and responsible manner
- 5) Perform common laboratory techniques including reflux, distillation, recrystallization, vacuum filtration.
- 6) Create and carry out work up and separation procedures.

#### V. Syllabus:

##### A. Organic preparations: 40M

- 1) Acetylation of one of the following compounds: amines (aniline, o-, m-, ptoluidines and o-, m-, p-anisidine)
  - a. Using conventional method.
  - b. Using green approach
- 2) Benzoylation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine)
- 3) Nitration of any one of the following:  
Acetanilide/nitrobenzene by conventional method

##### B.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

**VI. Co-curricular activities and assessment methods:**

1. Continuous Evaluation: Monitoring the progress of student's learning
2. Class Tests, Worksheets and Quizzes
3. Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality
4. Semester-End Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**VII. List of reference books:**

- 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 Agarwal R. Comprehensive Practical Organic Chemistry, University press.
- 4) Web related references suggested by teacher.

**VIII. Suggested Question Paper Pattern(Theory): Max.Marks: 75(Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks

(At least 1 question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks (At least 1 question should be given from each Unit).

**SUBJECT EXPERTS :**

1. Dr. K. Rayappa Reddy, Andhra Loyola college, Vijayawada.
2. Dr CA Jyothirmayee, Ch SD St Theresa's college for women, ELURU.
3. Dr. Shantha, St Joseph's college, Kurnool.
4. Dr M. Gopi, Dr VS. Krishna GDC Visakhapatnam.

**SYLLABUS VETTED BY:**

Prof. C. Suresh Reddy Professor, Department of Chemistry S.V. University Tirupati.



## **ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION**

(A Statutory body of the Government of Andhra Pradesh)

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### **REVISED SYLLABUS OF B.Sc. (Chemistry) UNDER CBCS FRAMEWORK WITH EFFECT FROM 2023 -24**

### **PROGRAMME: FOUR-YEAR UG HONOURS PROGRAMME IN SINGLE MAJOR CHEMISTRY**

*(With Learning Outcomes, Unit-wise Syllabus, References, Co-curricular Activities &  
Model Q.P.)*

Courses of V Semester

(To be Implemented from 2023-24 Academic Year)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**SEMESTER-WISE REVISED UGSYLLABUS UNDER CBCS FROM 2023-24**  
**FOUR YEAR -B.SC.(HONS), DOMAIN SUBJECT: CHEMISTRY COURSES**  
**FOR SEMESTERS V-SKILL ENHANCEMENT COURSES.**

*(SYLLABUS WITH LEARNING OUTCOMES, REFERENCE BOOKS & CO-CURRICULAR ACTIVITIES)*

Semester	Major/ Minor	Course No	Title of the course	Theory - No of hours per week	Theory - No of credits	Practical- No of hours per week	Practical- No of credits	Total No of credits
<b>V</b>	<b>Minor &amp; major</b>	<b>X A</b>	Analytical Methods in Chemistry-Quantitative analysis.  <b>(Or)</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
		<b>X B</b>	Environmental Chemistry					
	<b>Minor &amp; major</b>	<b>XI A</b>	Chromatography and Instrumental methods of Analysis.  <b>(Or)</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>
		<b>XI B</b>	Green Chemistry and Nanotechnology					
<b>Major</b>	<b>XII A</b>	Synthetic Organic Chemistry  <b>(Or)</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>	
	<b>XII B</b>	Industrial Chemistry Fertilisers and Surface coatings						
<b>Major</b>	<b>XIII A</b>	Analysis of Organic Compounds  <b>(Or)</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>4</b>	
	<b>XIII B</b>	Industrial Chemistry Polymers and water analysis						

**Note-1:** In Semester-V for the domain subject Chemistry, Skill Enhancement Courses shall be chosen - course A or B from the list of Courses given .

*Note-2: One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the skills embedded in syllabus citing related real field situations.*

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24**  
**FOUR YEAR -B.Sc.(HONS),DOMAIN SUBJECT: CHEMISTRY**  
**SEMESTER-V COURSE 10A[MAJOR AND MINOR]**  
**ANALYTICAL METHODS IN CHEMISTRY-QUANTITATIVE ANALYSIS**  
**SKILL ENHANCEMENT COURSE (ELECTIVE)**  
(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)

**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 the minimization methods.

**II. Syllabus:**

**Unit-1: Quantitative analysis-1 (9 hours)**

A brief introduction to analytical methods in chemistry. 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.. Description and use of common laboratory apparatus- volumetric flask, burette, pipette, beakers, measuring cylinders.

**Unit-2: Quantitative analysis-2 (9 hours)**

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. Principles of gravimetric analysis: precipitation, coagulation, peptization, coprecipitation, post precipitation, digestion, filtration, and washing of precipitate, drying and ignition.

**Unit-3: Treatment of analytical data (9 hours)**

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 (9hours)**

Solvent Extraction: Introduction, principle, techniques, factors affecting solvent extraction, Batch extraction, Continuous extraction and counter current extraction. Synergism.

Application-Determination of Iron(III). Ion Exchange method: Introduction, action of ion exchange resins, applications.

#### **UNIT-5: Analysis of water ( 9 hours)**

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

#### **III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz(on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.

#### **IV. List of Reference Books:**

- 1) Fundamentals of Analytical Chemistry by F.James Holler, Stanley R Crouch, DonaldM.West and Douglas A. Skoog, Ninth edition, Cengage.
- 2) Analytical Chemistry by Gary D.Christian, PurnenduK.Dasgupta and KevinA. Schug, Seventh edition, Wiley.
- 3) Quantitative analysis by R.A.DayJr.andA.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.

#### **Laboratory course: 10A (Semester V)**

#### **Analytical Methods in Chemistry – Quantitative analysis:**

(30hrs - 2hrs /wk) (Max.50 Marks- Credits – 1)

#### **V. 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

#### **VI. Laboratory course Syllabus:**

- 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.

#### **VII. Co-Curricular Activities:**

Mandatory: (Lab /field training of students by teacher: (lab:10+field:05):

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques / skills of calibration of pH meter, Strong acid vs strong base titration using pH meter, determination of chloride ion, estimation of water quality parameters and estimation of Iron(II).
- 2) **For Student:** Student shall visit a related industry / chemistry laboratory in universities / research organizations/private sector facility and observe various methods used for the analysis of water. Write their observations and submit a hand written fieldwork /project work report not exceeding 10 pages in the given format to the teacher.
- 3) **Max marks for Field work / projectwork Report:05.**
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

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

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

#### **IX. Suggested Question Paper Pattern(Theory): Max.Marks: 75(Time: 3 hrs)**

##### **SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks  
(At least 1question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks  
(At least 1question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**

**SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24**

**FOUR YEAR -B.Sc.(HONS),DOMAINSUBJECT:CHEMISTRY**

**Semester V - Course 10 B [Major and Minor]**

**Chromatography and Instrumental methods of Analysis**

**Skill Enhancement Course (Elective)**

(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)

**I. Learning Outcomes:**

- 1) Students after successful completion of the course will be able to:
- 2) Identify the importance of chromatography in the separation and identification of compounds in a mixture
- 3) Acquire a critical knowledge on various chromatographic techniques.
- 4) Demonstrate skills related to analysis of water using different techniques.
- 5) Understand the principles of spectrochemistry in the determination of metal ions.
- 6) Comprehend the applications of atomic spectroscopy.

**II. Syllabus:**

**Unit-1: Chromatography-Introduction and classification (9 hours)**

Principle, Classification of chromatographic methods, Nature of adsorbents, eluents, Rf values, factors affecting Rf values.

**UNIT-2: TLC and paper chromatography (9hours)**

Thin layer chromatography: Principle, Experimental procedure, preparation of plates, adsorbents and solvents, development of chromatogram, detection of spots, applications and advantages.

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 (9 hours)**

Column chromatography: Principle, classification, Experimental procedure, stationary and mobile phases, development of the Chromatogram, applications.

HPLC: Basic principles, instrumentation–block diagram and applications.

#### **UNIT-4: Spectrophotometry ( 9 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  $\text{Fe}^{+2}$ ,  $\text{Mn}^{+2}$  and  $\text{Pb}^{+2}$ .

#### **UNIT-5: Polarimetry and Refractometry ( 9 hours )**

Polarimetry and Refractometry: Polarimetry: Nature of polarized light, polarimeter, sample cells, operation of the polarimeter, optical purity. Refractometry; The refractive index, Refractometer.

#### **III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts

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

- 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.
- 5) Instrumental methods of Chemical Analysis by Dr.B.K.Sharma 1981

#### **Laboratory Course - 10-B:**

#### **Chromatography and Instrumental methods of Analysis**

(30hrs - 2hrs /wk ) (Max.50 Marks- Credits – 1)

#### **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. Laboratory course Syllabus:**

- 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. Co-Curricular Activities:**

Mandatory: (*Lab /field training of students by teacher:(lab:10+field:05):*)

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of determination of hardness of water, using the calorimeter and or Spectrophotometer, preparation of TLC plate, identification of spots in TLC and Paper chromatographic techniques, loading of column, selection of solvent system, separation of amino acids and dyes mixture using chromatographic techniques.
- 2) **For Student:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the chromatographic techniques used for the separation of compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork/project work Report: 05 **Max marks for Field work / project work Report:05.**
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

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

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

#### **IX. Suggested Question Paper Pattern(Theory) :Max.Marks:75 ( Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**  
Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks)

(At least 1 question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks)

(At least 1 question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24**  
**FOUR YEAR -B.SC.(HONS),DOMAIN SUBJECT:CHEMISTRY**  
**Semester V - Course 11 A [Major and Minor]**  
**Environmental Chemistry**  
**Skill Enhancement Course (Elective)**  
(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)

**I. Learning Outcomes:**

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

- 1) Understand the environment functions and how it is affected by human activities.
- 2) Acquire chemical knowledge to ensure sustainable use of the world's resources and ecosystems services.
- 4) Engage in simple and advanced analytical tools used to measure the different types of pollution.
- 5) Explain the energy crisis and different aspects of sustainability.
- 6) Analyze key ethical challenges concerning biodiversity and understand the moral principles, goals
- 7) and virtues important for guiding decisions that affect Earth's plant and animal life.

**II Syllabus**

**UNIT-I Environmental chemistry 9h**

Definition – Concept of Environmental chemistry-Scope and importance of environment in now a days – 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 Hydrological cycle.

**UNIT-II Air Pollution 9h**

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 – Green house effect – Formation and depletion of ozone – Bhopal gas disaster-Instrumental techniques to monitor pollution – Controlling methods of air pollution.

### **UNIT-III**

#### **Water pollution      9h**

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 into soft water – Methods to convert permanent hard water into soft water – eutrophication and its effects –Industrial waste water treatment.

### **UNIT-IV**

#### **Chemical Toxicology      9h**

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**

**9h**

##### **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)

##### **Bio diversity:**

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

#### **X. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, Group discussions, Debates and Quiz(on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.
- 5) Preparation of videos on tools, techniques on selected topics.

#### **XI. 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, SMKhopkar ( 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
10. Web related references suggested by teacher.

**Semester – V - Laboratory Course - 11-A**  
**Environmental Chemistry**

(30hrs - 2hrs /wk ) (Max.50 Marks- Credits – 1

**XII. Learning Outcomes:**

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

1. List out, Identify and handle various equipment in Chemistry lab.
2. Learn the procedures of preparation of standard solutions.
3. Demonstrate skills in operating instruments.
4. Acquire skills in handling spectrophotometer.
5. Analyze water and soil samples.

**XIII.Laboratory course Syllabus:**

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 pHmetry.

**XIV.Suggested Co-Curricular Activities:**

Mandatory:(*Lab /field training of students by teacher:(lab:10+field:05):*

- 1) For Teacher: Skills training of students by the teacher in classroom, lab and field for not less than 15 hours on field related quantitative techniques for the water quality parameters, soil pollution and air pollution.
- 2) For Student: Individual visit to any one of the local field agencies/research laboratories in universities/research organizations/private sector culminating writing and submission of a handwritten fieldwork/project work Report not exceeding 10 pages in the given format.
- 3) Max marks for Field work / project work Report:05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

**XV. 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, SMKhopkar ( IIT Bombay )
4. Web related references suggested by teacher.

**XVI.Suggested Question Paper Pattern (Theory): Max.Marks:75 ( Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks)(At least 1question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks  
(At least 1question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION  
SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24  
FOUR YEAR -B.SC.(HONS),DOMAINSUBJECT:CHEMISTRY  
Semester V - Course 11 B [Major and Minor] Green  
Chemistry and Nanotechnology.  
Skill Enhancement Course (Elective)  
(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)**

**I. Learning Outcomes:**

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

1. Understand the importance of Green chemistry and Green synthesis.
2. Engage in Microwave assisted organic synthesis.
3. Demonstrate skills using the alternative green solvents in synthesis.
4. Demonstrate and explain enzymatic catalysis .
5. Analyse alternative sources of energy and carry out green synthesis.
6. Carry out the chemical method of nanomaterial synthesis.

**II. Syllabus**

**UNIT-I Green Chemistry: I**

**9hrs**

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 sono chemical reactions (Heck, Hundsdiecker and Wittig reactions).

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

**9hrs**

**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: 9hrs**

Apparatus required, examples of MAOS (synthesis of fused anthroquinones, Leukart 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 9hrs**

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

1. Green synthesis of the following compounds : adipic acid, catechol, disodium imino diacetate (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 9hrs**

Basic concepts of Nanoscience and Nanotechnology – Bottom-up approach and Top down approaches with examples – Synthesis of Nano materials – Classification of Nanomaterials – Properties and Application of Nanomaterials. 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. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, Group discussions, Debates and Quiz (on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.
- 5) Preparation of videos on tools, techniques and applications of Green chemistry and Nanosynthesis.

**IV. List of 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)

- Principles and practice of heterogeneous catalysis, Thomas J.M., Thomas M.J., John Wiley
- Green Chemistry: Environmental friendly alternatives R S Sanghli and M.M Srivastava, Narosa Publications
- Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press (2008).
- Green Processes for Nanotechnology: From Inorganic to Bioinspired Nanomaterials, Vladimir A. Basiuk, Elena V. Basiuk Springer (2015)
- Web related references suggested by teacher.

**Semester – V - Laboratory Course - 11-B**  
**Environmental Chemistry**  
 (30hrs - 2hrs /wk ) (Max.50 Marks- Credits – 1)

**V. Learning Outcomes:**

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

- List out, identify and handle various equipment in the laboratory.
- Learn the procedures of green synthesis.
- Demonstrate skills in the preparation of Nanomaterials.
- Acquire skills in Microwave assisted organic synthesis.
- Perform some applications of Nanomaterials.

**VI. Laboratory course Syllabus:**

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

**VII. Suggested Co-Curricular Activities:**

Mandatory: *(Lab /field training of students by teacher: (lab:10+field:05):*

- For Teacher:** Training of students by the teacher in the classroom or in the laboratory for not less than 15 hours on field related quantitative techniques for Enzymatic catalysis, Microwave assisted organic synthesis, Biodiesel preparation etc
- For Student:** Student shall visit a related industry / chemistry laboratory in universities / research organizations/private sector facility and observe various methods used for the analysis of water. Write their observations and submit a

hand written fieldwork /project work report not exceeding 10 pages in the given format to the teacher.

- 3) **Max marks for Field work / project work Report:05.**
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

#### **VIII. List of 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) Web related references suggested by teacher.

#### **IX. Suggested Question Paper Pattern(Theory) : Max. Marks: 75 (Time: 3 hrs)**

##### **SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

##### **SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks)(At least 1 question should be given from each Unit)

##### **SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks)

(At least 1 question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24**  
**FOUR YEAR -B.SC.(HONS),DOMAIN SUBJECT:CHEMISTRY**  
**Semester V - Course 12 A [Major only] Synthetic Organic**  
**Chemistry.**

**Skill Enhancement Course (Elective)**  
**(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)**

**I. Learning Outcomes:**

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

- 1) Identify the importance of reagents used in the synthesis of organic compounds.
- 2) Acquire knowledge on basic concepts in different types of pericyclic reactions.
- 3) Understand the importance of retro synthesis inorganic chemistry.
- 4) Comprehend the applications of different reactions in synthetic organic chemistry.

**II. Syllabus:**

**Unit-1:Pericyclic reactions 9 hours**

Definition and classification of pericyclic reactions: Phases, nodes and symmetry properties of molecular orbital's in ethylene, 1,3-butadiene, 1,3,5-hexatriene, alkylation and allyl radical. Thermal and photochemical reactions. Electro cyclic reactions: Definition and examples, definitions of con and disrotation, Woodward-Hoffmann selection rules. (Correlation diagrams excluded) Cyclo addition reactions: Definition and examples, definitions of supra facial and antar facial addition, Woodward- Hoffmann selection rules. (Correlation diagrams excluded)

**Unit-2 : Organic photochemistry 9hours**

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

**Unit-3 : Retrosynthesis 9 hours**

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

**Unit-4 : Synthetic Reactions 9 hours**

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

**Unit-5 : Reagents in Organic Chemistry 9 hours**

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

Reducing agents :  $\text{LiAlH}_4$ (with mechanism), LTBA, Metal-solvent reduction (Birch reduction), Catalytic reduction.

**III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field / industrial experts.

**IV. List of Reference books:**

- 1) Pericyclic reactions by Ian Fleming, Second edition, Oxford University press.
- 2) Pericyclic 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

**Semester – V - Laboratory Course - 12-A**

**Synthetic Organic Chemistry**

(30hrs - 2hrs /wk ) (Max.50 Marks- Credits – 1)

**V. Learning Outcomes:**

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

- 1) Perform the organic qualitative analysis for the detection of N, S and halogens using the green procedure.
- 2) Learn the procedure for the separation of mixture of amino acids using paper Chromatography.
- 3) Prepare the TLC plates for TL chromatography.
- 4) Acquire skills in conducting column chromatography for the separation of dyes in the given mixture.

**VI. Laboratory course syllabus:**

- 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 methylene blue by column chromatography
- 5) Separation of food dyes using Column Chromatography
- 6) Separation of triglycerides using TLC

#### **VII. Suggested Co-Curricular Activities**

- 1) Mandatory: *(Lab/field training of students by teacher: (lab:10+field:05):*
- 2) For Teacher: Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of detection of N, S and halogens using the green procedure, preparation of TLC plates, detection of organic compounds using R<sub>f</sub> values in TLC / paper chromatography, loading of column, selection of solvent system for column chromatography, separation of amino acids and dye mixture using chromatographic techniques.
- 3) For Students : Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the synthetic reactions. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 4) Max marks for Fieldwork/project work Report: 05.
- 5) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
- 6) Unit tests (IE).

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

- 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.

#### **IX. Suggested Question Paper Pattern (Theory) : Max. Marks: 75 (Time: 3 hrs)**

##### **SECTION- A ( Total : 5x2 = 10 Marks )**

Very Short Answer Questions

##### **SECTION-B ( Total: 5x5 = 25 Marks )**

(Answer any five questions. Each answer carries 5 marks)

(At least 1 question should be given from each Unit)

##### **SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks)

(At least 1 question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24**  
**FOUR YEAR -B.SC.(HONS),DOMAINSUBJECT:CHEMISTRY**  
**Semester V - Course 12 B [Major only]**  
**Analysis of Organic Compounds**  
**Skill Enhancement Course (Elective)**  
**(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)**

**I. Learning Outcomes:**

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

- 1) Identify the importance of mass spectrometry in the structural elucidation of organic compounds.
- 2) Acquire the knowledge on structural elucidation of organic compounds.
- 3) Understand various chromatography methods in the separation and identification of organic compounds.
- 4) Demonstrate the knowledge gained in solvent extraction for the separate the organic compounds.

**II. Syllabus:**

**Unit-I: Nuclear Magnetic Resonance (NMR) spectroscopy 9 h**

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, 1,1,2tribromo ethane, ethyl acetate, toluene and acetophenone.

**Unit II Mass Spectrometry 9hrs**

A brief introduction to analysis of organic compounds

Basic principles, Instrumentation - Mass spectrometer, electron Ionization (Electron Impactionization, EI), Molecular ions, metastable ions, Isotope abundance. Basic fragmentation types. Fragmentation patterns in Toluene, 2-Butanol, Butaldehyde, Propionicacid.

**Unit-III : Structural elucidation of organic ompounds using IR,NMR & mass spectral data- 9 hours**

2,2,3,3-Tetramethyl butane,Butane-2,3-dione,Propionicacid and methyl propionate.

Phenyl acetylene, acetophenone, cinnamic acid and p-nitroaniline.

**Unit-IV: Separation techniques-1 9 hours**

Solvent extraction-Principle and theory, Batch extraction technique, application of batch extraction in the separation of organic compounds from mixture- acid & neutral, base & neutral.

Chromatography – Principle and theory, classification, types of adsorbents, eluents, Rf values and factors affecting Rf values. Thin layer chromatography - principle, experimental procedure, advantages and applications.

### **Unit-5: Separation techniques - 2 9 hours**

Paper chromatography- Principle, experimental procedure, ascending, descending, radial and two dimensional, applications.

Column chromatography - Principle, classification, experimental procedure and applications.

HPLC-Principle, Instrumentation – block diagram and applications.

### **III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field / industrial experts.

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

- 1) Organic Spectroscopy by William Kemp, Third Edition, Palgrave USA.
- 2) Introduction to Spectroscopy by Pavia, Lampman, Kriz and Vyvyan, Fifth edition, Cengage.
- 3) Organic Spectroscopy: Principles and Applications by Jag Mohan, Second edition, Alpha Science.
- 4) Spectroscopy of Organic Compounds by P.S.Kalsi, Seventh edition, New Age International.
- 5) Spectroscopic Methods in Organic Chemistry by Ian Fleming and Dudley Williams, Seventh edition, Springer.
- 6) Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West and Douglas A. Skoog, Ninth edition, Cengage.
- 7) Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta and Kevin A. Schug, Seventh edition, Wiley.
- 8) Quantitative analysis by R.A. Day Jr. and A.L. Underwood, Sixth edition, Pearson.
- 9) Text book of Vogel's Quantitative Chemical Analysis, Sixth edition, Pearson.

### **Semester – V - Laboratory Course - 12-B**

#### **Analysis Of Organic Compounds (30hrs**

**- 2hrs /wk )**

**(Max.50 Marks- Credits – 1) V. Learning**

**Outcomes:**

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

- 1) Prepare acetanilide using the green synthesis.
- 2) Demonstrate the preparation of an azo dye.
- 3) Acquire skills in the separation of organic compounds in the given mixture using solvent extraction

#### **VI. Laboratory course Syllabus:**

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

#### **VII. Suggested Co-Curricular Activities:**

Mandatory: (*Lab / field training of students by teacher:(lab:10+field:05):*)

- 1) For Teacher: Training of students by teacher in laboratory and field for not less than 15 hours on the field techniques/skills of preparation of acetanilide, preparation of azo dye, use of separating funnel for solvent extraction, separation of organic compounds in a mixture.
- 2) For Student : Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the techniques used for the separation of organic compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork / project work Report:05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
- 5) Unit tests(IE).

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

- 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) MannF.G and Saunders B.C, Practical Organic Chemistry, Pearson Education.

IX. **Suggested Question Paper Pattern(Theory) : Max. Marks: 75(Time: 3 hrs)**

**SECTION- A ( Total :5x2 =10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5=25Marks )**

(Answer any five questions. Each answer carries 5 marks)

(At least 1question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks)

(At least 1question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24**  
**FOUR YEAR -B.SC.(HONS),DOMAIN SUBJECT:CHEMISTRY**  
**Semester V - Course 13 A [Major only]**  
**Industrial Chemistry- Fertilisers and Surface coatings**  
**Skill Enhancement Course (Elective)**  
**(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)**

**I. Learning Outcomes:**

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

- 1) Identify the importance of different surface coatings.
- 2) Acquire a critical knowledge on manufacture of ceramics and cement.
- 3) Understand various steps in the manufacture of cane sugar.
- 4) Explain the manufacture of pulp and paper.

**II. Syllabus:**

**Unit-1: Fertilizers 9 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 9 hours**

Ceramics: Important clays and Feldspar. Ceramics - types, uses and manufacture. High technology ceramics and their applications.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

**Unit-3 : Surface Coatings 9 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 9hours**

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

**Unit-5: Paper Industry 9 hours**

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

### **III. Suggested Co – Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, debates , discussions and Quiz(on related topics).
- 3) Visits to industries, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.
- 5) Preparation of PPTS and videos.

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

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

**Semester – V - Laboratory Course - 13-A**  
**Industrial Chemistry- Fertilizers and Surface coatings**  
**(30hrs - 2hrs /wk ) (Max.50 Marks- Credits – 1)**

### **V. Learning 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 colorimeter for the estimation of sucrose.

### **VI. Laboratory course Syllabus:**

- 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.

### **VII. Suggested Co-Curricular Activities:**

Mandatory:(*Lab / field training of students by teacher* :(*lab:10+field:05*):

- 1) For Teacher: Training of students by the teacher in laboratory and field for not less than 15hours on field related skills in determination of free acidity, estimation of calcium and phosphoric acid in a fertilizer, use of colorimeter to estimate sucrose.

- 2) For Student :Student shall visit a related industry /chemistry laboratory in universities/research organizations/private sector facility and observe the surface coatings of surfaces used to prevent the corrosion. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Field work/ project work Report: 05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
- 5) Unit tests (IE).

**VIII. List of Reference books:**

- 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

**IX. Suggested Question Paper Pattern (Theory) : Max. Marks: 75 (Time: 3 hrs)**

**SECTION- A ( Total : 5x2 = 10 Marks )**

Very Short Answer Questions

**SECTION-B ( Total: 5x5 = 25 Marks )**

(Answer any five questions. Each answer carries 5 marks)

(At least 1 question should be given from each Unit)

**SECTION-C ( Total: 5x8 = 40 Marks)**

(Answer any five questions. Each answer carries 10 marks) (At least 1 question should be given from each Unit)

**A.P.STATE COUNCIL OF HIGHER EDUCATION**  
**SEMESTER-WISE REVISED SYLLABUS UNDER CBCS2023-24**  
**FOUR YEAR -B.Sc.(HONS),DOMAIN SUBJECT:CHEMISTRY**  
**Semester V - Course 13 B [Major only]**  
**Industrial Chemistry- Polymers and water analysis**  
**Skill Enhancement Course (Elective)**  
**(45hrs - 3hrs /wk) (Max.100 Marks- Credits – 3)**

**I. Learning Outcomes:**

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

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

**II. Syllabus:**

**Unit-1: Organic Polymers-1            9 hours**

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

**Unit-2: Organic Polymers-2            9 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 acrylo nitrile, Poly methacrylate, Polymethylmethacrylate.

**Unit-3: Air Pollution                    9 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    9hours**

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 9 hours**

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 and filling - economic, aesthetic and environmental problems.

### **III. Suggested Co- Curricular Activities**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, discussions and Quiz(on related topics).
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field / industrial experts.

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

- 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 : NewAgeInternational Pvt, Ltd, NewDelhi.
- 8) C.k.Varshney:Water Pollution and Management,Wiley Eastern Limited, Chennai.
- 9) S.S. Dara and D.D. Mishra: Text book of Environmental Chemistry and Pollution Control, Revised edition, S.C.Hand&CoLtd.

**Semester – V - Laboratory Course – 13- B**  
**Industrial Chemistry- Polymers and water analysis**  
**(30hrs - 2hrs /wk ) (Max.50 Marks- Credits – 1)**

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

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

- 1) Learn the procedures for the determination of BOD and COD.
- 2) Demonstrate skills in the determination of chloride in the given water sample.
- 3) Acquire skills in determining the hardness of water.
- 4) Analyse the soil samples
- 5) Handle pHmeter.

### **VI. Laboratory course Syllabus:**

- 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 pHmetry.

## VII. Suggested Co-curricular activities

Mandatory: (Student training by teacher in field related skills: in lab: 15, in field: 05 hours):

- 1) For Teacher: Training of students by the teacher in laboratory and field for not less than 15 hours on the field related skills in the determination of hardness of water, estimation of COD and BOD in water sample, determination of chloride ion in water sample.
- 2) For Student: Student shall visit a related industry /chemistry laboratory in universities/research organizations /private sector facility and observe the measurement of water quality parameters. Write their observations and submit a hand written field work / project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork/project work Report: 05.
- 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
- 5) Unit tests (IE).

## VIII. List of Reference books :

- 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.

**IX. Suggested Question Paper Pattern (Theory) :** Max. Marks: 75 (Time: 3 hrs)

### SECTION- A ( Total : 5x2 = 10 Marks )

Very Short Answer Questions

### SECTION-B ( Total: 5x5=25 Marks )

(Answer any five questions. Each answer carries 5 marks)

(At least 1 question should be given from each Unit)

### SECTION-C ( Total: 5x8 = 40 Marks)

(Answer any five questions. Each answer carries 10 marks)

(At least 1 question should be given from each Unit)

**SUBJECT EXPERTS :**

1. Dr. K. Rayappa Reddy, Andhra Loyola college, Vijayawada.
2. Dr CA Jyothirmayee,  
Ch SD St Theresa's college for women,  
ELURU.
3. Dr. Shantha,  
St Joseph's college,  
Kurnool.
4. Dr M. Gopi,  
Dr VS. Krishna GDC  
Visakhapatnam.

**SYLLABUS VETTED BY:**

Prof. C. Suresh Reddy Professor,

Department of Chemistry  
S.V. University Tirupati.



## **ANDHRA PRADESH STATE COUNCIL OF HIGHERE DUCATION**

(A Statutory body of the Government of Andhra Pradesh)

3<sup>rd</sup>,4<sup>th</sup>and5<sup>th</sup>floors, Neeladri Towers,  
Sri Ram Nagar, 6<sup>th</sup>Battalion Road,Atmakur(V),Mangalagiri(M),  
Guntur-522503,Andhra Pradesh  
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### **REVISED SYLLABUS OF FOUR YEARS B.SC.HONS. (CHEMISTRY) UNDER CBCS FRAME WORK WITH EFFECT FROM 2023 -24**

#### **PROGRAMME: FOUR-YEAR UG HONOURS PROGRAMME IN SINGLE MAJOR CHEMISTRY**

*(With Learning Outcomes, Unit-wise Syllabus, References, Co-curricular Activities &Model Q.P.)*  
Courses of 7<sup>th</sup>&8<sup>th</sup>Semesters)  
(To be Implemented from 2023-24 Academic Year)

ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

**REVISED UG SYLLABUS UNDER CBCS**

(Implemented from Academic Year, 2023-24)

PROGRAMME:FOURYEARB.Sc.(Hons) CHEMISTRITY Domain

Subject :CHEMISTRY

***Courses for Semesters - VII&VIII***

*(Syllabus with Learning Outcomes, References & Co-curricular Activities)*

**Structure of Courses for Semester–VII**

(Choose A or B from the Two alternate courses)

Un i.C ode	Course No.	Name of Course	Theory Internal exam Marks	TheoryExternal Exam Marks	TheoryexamCred its	Practic al Marks	Practic al Credits
	14A	Inorganic Chemistry: Advance Studies in Complexes and Group theory	25	75	3	50	1
	14B	Inorganic Materials of Industrial importance	25	75	3	50	1
	15A	Spectroscopy of Organic compounds	25	75	3	50	1
	15B	Stereo Chemistry and Natural Products	25	75	3	50	1
	16A	Physical Chemistry: Thermo dynamics, Electro chemistry and Chemical Kinetics.	25	75	3	50	1
	16B	Instrumental Methods of Chemical Analysis	25	75	3	50	1
	17A	Green Chemistry	25	75	3	50	1
	17B	Analysis of Drugs, Dairy Products & Chemical Analysis	25	75	3	50	1
	18A	Polymer Chemistry	25	75	3	50	1
	18B	Industrial Chemicals and Environment	25	75	3	50	1
	19	Open Online trans disciplinary course			2		
Total credits					17		5 =22

### Structure of Courses for Semester–VIII

(Choose A or B from the Two alternate courses)

U n i v. C o u r s e	Course NO.	Name of Course	Theory Internal Exam Marks	Theory External Exam Marks	Theory Exam Credits	Practic al Exam Marks	Practical Exam Credits
	20A	Inorganic Chemistry: Metal Cluster, Electronic spectra of Complex compounds and Bio-inorganic chemistry	25	75	3	50	1
	20B	Organo metallic Chemistry	25	75	3	50	1
	21A	Modern Organic synthesis and Natural Products	25	75	3	50	1
	21B	Chemistry of Natural products	25	75	3	50	1
	22A	Physical Chemistry: Quantum And Molecular Spectroscopy	25	75	3	50	1
	22B	Analytical Methods of Analysis	25	75	3	50	1
	23A	Pharmaceutical and Medicinal Chemistry	25	75	3	50	1
	23B	Pesticides and Green Chemistry	25	75	3	50	1
	24A	Corrosion and Its Prevention	25	75	3	50	1
	24B	Material & Energy Balances and Utilities in Chemical Industry	25	75	3	50	1
	25	Open Online trans disciplinary course			2		
Total no of credits					17		5=22

**Note-1:** For Semester–VII&VIII, for the domain subject Chemistry, Three Core courses and Two Skill Enhanced Courses shall be chosen course A or B from the list of Courses in each Semester. Three pairs of Core Courses are 14A&14B, 15A&15B, 16A&16B for SemVII and 20A&20B, 21A&21B, 22A&22B for Sem-VII. Two Pairs of Skill Enhanced

Courses are 17A&17B, 18A&18B for Sem-VII and 23A & 23B, 24A&24B from SemVIII. One Online Course chosen from Swayam/NPTEL/Any other courses recognized by universities per semester-VII and VIII.

**Note-2:** One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented.

*Hence, teachers shall also impart practical training to students on the skills embedded in syllabus citing related real field situations.*

A.P. State Council of Higher Education  
Semester-wise Revised Syllabus under CBCS 2023-24

## **Four Year - B.Sc. (Hons), Semester – VII**

Domain Subject: CHEMISTRY

### **Course 14A: Inorganic Chemistry-I: Advance Studies in Complexes and Group theory**

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

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

- 1) The student will understand the VSEPR theory, symmetric and unsymmetric Hydrogen bonds in inorganic molecules.
- 2) Understanding the Crystal field theory and Jahn Teller Effects.
- 3) The Students will be able to understand the basics of molecular orbital theory and energetic of hybridization.
- 4) The Students are able to understand the Jobs method, hard and soft acids and bases. 5)The students will acquire the knowledge of symmetry

#### **II. Syllabus: Total: 45hours(3hr/Week)**

##### **Unit-I: Chemistry of non- transition elements: 9 Hours**

Inter halogen compounds, Halogen oxides and oxyfluorides, Clathrate compounds, Spectral and Magnetic properties of Lanthanides and Actinides. Analytical applications of Lanthanides and Actinides. Synthesis, properties and structure of B-N, S-N,P-N cyclic compounds. Intercalation compounds.

**Metal  $\pi$ - complexes:** preparation, structure and bonding in Nitrosyl, Dinitrogen and Dioxygen complexes.

##### **Unit-II: Structure and Bonding: 9 Hours**

$\pi$ - $d\pi$  bonding, Bent's rule, Non-valence cohesive forces, VSEPR theory. Molecular Orbital theory, Symmetry of Molecular orbitals, Molecular orbitals in triatomic( $\text{BeH}_2$ ) molecules and ions ( $\text{NO}_2^-$ ) and energy level diagrams. Application of MO theory to square planar

( $\text{PtCl}_4^{2-}$ ) and octahedral complexes( $\text{CoF}_6^{3-}$ , $\text{Co}(\text{NH}_3)_6^{3+}$ ). Walsh diagrams for linear ( $\text{BeH}_2$ ) and bent( $\text{H}_2\text{O}$ )molecules.

##### **Unit-III: Metal–ligand bonding: 9 Hours**

Crystal Field Theory of bonding in transition metal complexes-Splitting of d-orbitals in octahedral, tetrahedral, square planar and Trigonal bipyramidal and Square pyramidal fields. Tetragonal distortions - Jahn-Teller effect. Applications and limitations of CFT. Experimental evidences for covalence in complexes. Molecular Orbital Theory of bonding for Octahedral, tetrahedral and square planar complexes.  $\pi$ -bonding and MOT - Effect of  $\pi$  - donor and  $\pi$  – acceptor ligands on  $\Delta_o$ . Experimental evidence for  $\pi$ -bonding in complexes.

**Unit-IV: Metal–ligand Equilibrium solutions: 9 Hours**

Step wise and over all formation constants. Trends in stepwise constant (statistical effect and statistical ratio). Determination of formation constants by Spectrophotometric method (Job's method) and pHmetric method (Bjerrum's). Stability correlations-Irwing-William's series. Hard and soft acids and bases (HSAB), Acid-base strengths.

**Unit- V: Group theory 9 Hours**

Basic concepts of Symmetry and Group theory- Symmetry elements, symmetry operations and point groups. Schoenflies symbols-Classification of molecules into point groups–Axioms of Group theory– Group multiplication tables for  $C_{2V}$  and  $C_{3V}$  point groups–Similarity. Transformation and classes Representations–reducible and irreducible representations. Mulliken symbols, Orthogonality theorem and its implications, character table and its anatomy.

**III. Suggested Co-Curricular Activities**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to industries, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/ industrial experts.

**IV. List of Textbooks :**

- 1) Inorganic Chemistry Huheey, Harper and Row.
- 2) Physical methods in inorganic chemistry, R.S. Drago. Affiliated East-West Pvt. Ltd.
- 3) Concise inorganic chemistry, J.D. Lee, ELBS.
- 4) Modern Inorganic Chemistry, W.L. Jolly, McGraw Hill.
- 5) Inorganic Chemistry, K.F. Purcell and J.C. Kotz Holt Saunders international.
- 6) Concepts and method Of inorganic chemistry, B.E. Douglas and D.H.M.C. Daniel, oxford Press.
- 7) Introductory quantum Mechanics, A.K. Chandra.
- 8) Quantum Chemistry, R.K. Prasad.

**V. Reference books:**

- 1) Inorganic Chemistry, Atkins, ELBS.
- 2) Advanced Inorganic Chemistry, Cotton and Wilkinson, Wiley Eastern.
- 3) Text book of Coordination chemistry, K. Soma Sekhara Rao and K.N.K. Vani, Kalyani Publishers.
- 4) Group Theory and its Applications to Chemistry, K.V. Raman, Tata McGraw– Hill Publishing Company Ltd., New Delhi.
- 5) Chemical Applications of Group Theory, F.A. Cotton Wiley Eastern Limited New Delhi.

**Course 14A: [Inorganic Chemistry-I: Advance Studies in Complexes and Group theory practical Syllabus:](#)**

**VI. Learning Outcomes:**

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

- 1) List out, identify and handle various equipment in Chemistry lab.
- 2) Understand the basic concepts of qualitative analysis of inorganic mixture.
- 3) Apply the concepts of common ion effect, solubility product and concepts related to qualitative analysis..
- 4) Acquire skills in elimination interfering anion.. 5) Identification of less familiar cation.

## **VII.Syllabus: Total Hours: 30h (2h/week)**

- 1) Synthesis of Inorganic Metal Complexes:
- 2) Synthesis of 3d transition metal complexes of tetrahedral, square planar and octahedral geometries.
- 3) Tetra ammine copper (II) sulphate monohydrate
- 4) Potassium tris (oxalato) ferrate(III) trihydrate
- 5) Tris (thiourea) copper(I) sulphate

**Systematic Semi micro Qualitative Analysis of Inorganic six radical mixtures:** In systematic Semi micro qualitative inorganic analysis, inorganic mixture contains three cations and three anions. The analysis involves identification and conformation of cations and anions containing one less familiar cation (Tungsten, Molybdenum, Zirconium, Thorium, Titanium, Uranium, Cerium, Vanadium, Lithium, Berkelium etc.,) and one interfering anion.

### **Anions:**

CO<sub>3</sub><sup>2-</sup>, S<sub>2</sub><sup>2-</sup>, SO<sub>3</sub><sup>2-</sup>, Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, CH<sub>3</sub>COO<sup>-</sup>, C<sub>2</sub>O<sub>4</sub><sup>2-</sup>, C<sub>4</sub>H<sub>4</sub>O<sub>6</sub><sup>2-</sup>, PO<sub>4</sub><sup>3-</sup>, CrO<sub>4</sub><sup>2-</sup>, AsO<sub>4</sub><sup>3-</sup>, F<sup>-</sup>, BO<sub>3</sub><sup>3-</sup>

### **Cations :**

Ammonium (NH<sub>4</sub><sup>+</sup>)

1<sup>st</sup> group: Hg, Ag, Pb, Tl, W

2<sup>nd</sup> group: Hg, Pb, Bi, Cu, Cd, As, Sb, Sn, Mo 3<sup>rd</sup> group: Fe, Al, Cr, Ce, Th, Ti, Zr, V, U, Be 4<sup>th</sup> group: Zn, Mn, Co, Ni

5<sup>th</sup> group: Ca, Ba, Sr

6<sup>th</sup> group: Mg, K, Li

**Note:** A minimum of 4 inorganic mixtures must be analysed in this Semester.

## **VIII.Suggested Co-Curricular Activities**

**Mandatory:** (Lab/field training of students by teacher: (lab:10+field:05):

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of involves identification and conformation of cations and anions containing one less familiar cation and one interfering anion.
- 2) **For Students:** Student shall visit a related industry/chemistry laboratory in universities / research organizations / private sector facility and observes the synthetic reactions. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.

- 3) Max marks for Fieldwork/project work Report :05.
- 4) Suggested Format for Fieldwork/project work: Title page, student details, index page, details of place visited, observations, findings and acknowledgements.
- 5) Unittests(IE).

**IX. Reference Books:**

- 1) Practical Inorganic Chemistry,G.Marr and B.W.Rockett.
- 2) Practical Inorganic Chemistry by G.PassH. Sutchiffe, 2<sup>nd</sup>ednJohnWiley& Sons.
- 3) Experimental Inorganic / Physical Chemistry, M.A.Malati, Horwood Publishing ,Chichester,UK(1999)
- 4) Vogel's text book of semi micro qualitative analysis, 5<sup>th</sup> Edition by G. Svehla.

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Semester-wise Revised Syllabus under CBCS 2023-24  
Four Year - B.Sc. (Hons), Semester – VII Domain  
Subject: **CHEMISTRY**

**Course 14B:** Inorganic Materials of Industrial importance

**I. Course learning Outcomes:**

**By the end of the course, the students will be able to:**

1. Learn the composition and applications of the different kinds of glass.
2. Understand glazing of ceramics and the factors affecting their porosity.
3. Give the composition of cement and discuss the mechanism of setting of cement.
4. Explain the suitability of fertilizers for different kinds of crops and soil.

- 5· Explain the process of formulation of paints and the basic principle behind the protection offered by the surface coatings.
- 6· Explain the principle, working and applications of different batteries.
- 7· List and explain the properties of engineering materials for mechanical construction used in day today life.
- 8· Explain the synthesis and properties of nano-dimensional materials, various semiconductor And superconductor oxides

## II. Syllabus

**Total: 45hours(3hr/Week)**

### **Unit 1:Silicate Industries: [9 hours]**

**Glass:** Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, leadglass, armoured glass, different types of safety glass, borosilicate glass, fluorosilicate glass, colouredglass, photosensitive glass, photochromic glass, glass wool and optical fibre.

**Ceramics:** Brief introduction to types of ceramics. glazing of ceramics.

### **Unit 2:Fertilizers: [9 hours]**

Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime, potassium chloride and potassium nitrate.

### **Unit 3:Batteries:[9 hours]**

Primary and secondary batteries, characteristics of an Ideal Battery, principle, working, applications and comparison of the following batteries: Pb- acid battery, Li-metal batteries, Li-ion batteries, Li-polymerbatteries, solid state electrolyte batteries, fuel cells, solar cells and polymer cells.

### **Unit 4:Synthesis of inorganic solids: [9 hours]**

Conventional heat and beat method, Co-precipitation method, Sol-gel method, Hydrothermal method, Chemical vapor deposition (CVD), Ion-exchange and Intercalation method.

### **Unit 5:Nanomaterials: [9 hours]**

Overview of nanostructures and nanomaterial's, classification, preparation and optical properties of gold and silver metallic nanoparticles, concept of surface Plasmon resonance, carbon nanotubes, inorganic nanowires, Bioinorganic nanomaterial's natural and artificial

nanomaterial's, self-assembled nanostructures, control of Nano architecture, one dimensional control.

### III. Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts

### IV. Suggested Text Books:

1. Poole Jr.; Charles P.; Owens, Frank J. (2003), **Introduction to Nanotechnology**, John Wiley and Sons
2. West, A. R. (2014), **Solid State Chemistry and Its Application**, Wiley
3. Smart, L. E.; Moore, E. A. (2012), **Solid State Chemistry An Introduction**, CRC PresTaylor&Francis.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A.(2010), **Shriver and Atkins Inorganic Chemistry**, W. H. Freeman and Company.
5. Kent, J. A. (ed) (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, NewDelhi.

### V. References:

1. Svehla, G.(1996), Vogel's Qualitative Inorganic Analysis, Prentice Hall.
2. Banewicz, J. J.; Kenner, C.T. Determination of Calcium and Magnesium in Limestones and Dolomites, Anal. Chem., 1952, 24 (7), 1186–1187.

## **Course 14B: Inorganic Materials of Industrial importance-Practicals syllabus**

### VI. Learning outcomes:

By the end of the course students will be able to:

1. Identify sulphate and ammonium ion present in ammonium sulphate fertilizer
2. Estimate the amount of calcium present in a fertilizer
3. Synthesize nanoparticles by chemical method
4. Synthesize metal doped metal oxide nanoparticles
5. Prepare and characterize silver nanoparticles.

### VII. Practical Syllabus:

**Total Hours: 30h(2h/week)**

1. Detection of constituents of Ammonium Sulphate fertilizer (Ammonium and Sulphate ions) by qualitative analysis and determine its free acidity.
2. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) fertilizer and estimation of Calcium content.

3. Synthesis of ZnO nanoparticles by chemical method and its characterization using UVvisible Spectrophotometer.
4. Cu doped ZnO nanoparticles
5. Synthesis of silver nanoparticles by green methods and its characterization using UVvisible Spectrophotometer.
6. Detection of constituents of Dolomite (Calcium, Magnesium and carbonate ions) and Determination of composition of Dolomite (Complexometric titration).

### VIII. Co-Curricular Activities:

**Mandatory:** *(Lab/field training of students by teacher : (lab:10+field:05):*

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of synthesis of nanoparticles and its characterization using various techniques.
2. **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the stages in cement preparation. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
3. Max. Marks for Fieldwork/project work Report: 05.
4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
5. Unit tests (IE).

### IX. References:

1. Ghorbani, H. R.; Mehr, F.P.; Pazoki, H.; Rahmani B. M. Synthesis of ZnO Nanoparticles by Precipitation Method. *Orient J Chem.* 2015;31(2).
2. Orbaek, W.; McHale, M.M.; Barron, A.R. Synthesis and characterization of silver nanoparticles for an undergraduate laboratory, *J. Chem. Educ.* 2015, 92, 339–344.

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Subject: **CHEMISTRY**

**Course 15A:** Spectroscopy of Organic compounds

**I. Learning Outcomes:**

**By the end of the course, the students will be able to:**

- 1) Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.
- 2) Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules
- 3) Interpret of IR, UV-visible spectra and their applications
- 4) Interpret of NMR, Mass spectra and their applications
- 5) Interpret the spectra in identifying the organic compounds

**II. Syllabus**

**Total: 45hours(3hr/Week)**

**Unit-I**

**[9 hours]**

**UV-Vis Spectroscopy**

Energy transitions – Simple chromophores – UV absorption of Alkenes –polyenes  
unsaturated cyclic systems – Carbonyl compounds,  $\alpha,\beta$ -unsaturated carbonyl systems -  
Woodward Fieser rules – aromatic systems – solvent effects – geometrical isomerism – acid

and base effects – typical examples – calculation of  $\lambda_{\max}$  values using Woodward - Fieser rules.

b) **ORD:** Theory of optical rotatory dispersion,  $\alpha$ -Axial haloketone rule and octant rule – Application of these rules in the determination of absolute configuration of cyclohexanones, decalones and cholestanones.

## **Unit-II** **[9 hours]**

**Infrared Spectroscopy (FT-IR):** Fundamental modes of vibrations – Stretching and bending vibrations – overtones, combination bands and Fermi resonance, factors influencing vibrational frequencies, hydrogen bonding – fingerprint region and its importance – Study of typical group frequencies for – CH, -OH, -NH, -CO-NH<sub>2</sub>, -CC, -CHO, -CO and aromatic systems. Application in structural determination – Simple problems

## **Unit-III** **[9 hours]**

### **<sup>1</sup>H NMR spectroscopy:**

a) Magnetic properties of Nuclei, Nuclear resonance, Fourier Transformation and its importance in NMR. Equivalent and non-equivalent protons, The chemical shift and its importance, calculation of chemical shift, factors affecting the chemical shifts such as electronegativity and anisotropy, effect of deuteration, Signal integration, Spin-spin coupling: vicinal (Karplus relationships), germinal and long range. Coupling constants ( $J$ ) and factors affecting coupling constants. –Shielding and deshielding mechanisms in acetylene carbonyl and Benzene, anisotropy –Spin-Spin Interactions related to first order and higher order spectra (AB, A<sub>2</sub>; AB<sub>2</sub>, ABX, ABC, AMX) –temperature dependence spectra, Hydrogen bonding.

## **Unit-IV** **[9 hours]**

### **Electron Spin Resonance Spectroscopy (ESR):**

Basic Principles, Comparison of NMR & ESR. Determination of 'g' value, Factors affecting the 'g' value. Isotropic and Anisotropic constants. Splitting, hyperfine splitting coupling constants. Line width, Zero field splitting, and Kramer degeneracy. Crystal field splitting, Crystal field effects.

**Applications:** Detection of free radicals; ESR spectra of (a) Methyl radical (CH<sub>3</sub>·), (b) Benzene anion (C<sub>6</sub>H<sub>6</sub><sup>-</sup>).

## UNIT-V

### MASS SPECTROMETRY

[9 hours]

Introduction, ion production, type of ionization, EI, CI, FD, and FAB-factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular-ion peak, metastable peak, Mac Lafferty rearrangement. Nitrogen rule, isotope labeling. High resolution mass spectrometry, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

#### III. Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

#### IV. Suggested Text Books:

1. Organic spectroscopy, W. Kemp 5th Ed, ELBS
2. Spectroscopy of organic compounds, RM Silversteen and others, 5th Ed, John Wiley
3. Spectroscopy of organic compounds, P.S. Kalsi, Wiley, 1993.

#### V. References:

1. NMR in chemistry-A multi nuclear introduction, William Kemp, McMillan, 1986.
2. Spectroscopic methods in Organic chemistry, DH Williams & I Flemmi

### Course 15A: Spectroscopy of Organic Compounds- Practical Syllabus

**Total Hours: 30h(2h/week)**

#### VI. Learning outcomes:

##### By the end of the course students will be able to

1. Identify the functional groups present in the molecules
2. Apply data to in identification of the molecule
3. Describe principles involved in Spectroscopic methods
4. Predict number of signals, splitting patterns in the proton NMR of a compound
5. Develop ability in the combined use of mass spectrometry and spectroscopic techniques for structure elucidation

#### VII. Practical Syllabus

- a) Problems involving individual spectral methods – UV, IR, PMR and Mass

- b) Problems involving combined any two of UV, IR, PMR and Mass
- c) Problems involving combined any three of UV, IR, PMR and Mass
- c) Problems involving all four UV, IR, PMR and Mass spectral data.

### VIII. Co-Curricular Activities:

**Mandatory:** (Lab/field training of students by teacher: (lab:10+field:05):

- 1. For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of detection of organic compounds using spectroscopic data.
- 2. For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the synthetic reaction and obtaining spectral data and analyzing the organic compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
3. Max. Marks for Fieldwork/project work Report: 05.
4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
5. Unit tests (IE).

### IX. References:

1. NMR in chemistry-A multi nuclear introduction, William Kemp, McMillan, 1986.
2. Spectroscopic methods in Organic chemistry, DH Williams & I Flemmi

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**Four Year - B.Sc. (Hons), Semester – VII**  
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**Course 15 B: Organic Chemistry: Stereo Chemistry and Natural Products**

**I. Course Learning outcomes:**

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

- 1) Understand and apply the substitution and elimination reaction mechanisms at aliphatic and aromatic substrates for various reactions leading to research 2) Write the stereo chemical forms for different organic molecules.
- 3) Understand the conformations of acyclic, monocyclic and fused ring systems and applying it to organic compounds.
- 4) Explain formation of various heterocyclic compounds and their synthesis and importance.
- 5) Describe the importance of natural products in medicinal chemistry

**II. Syllabus:**

**Total : 45 hours( 3hr/Week)**

**Unit – I Reaction Mechanism**

**9 Hours Aliphatic**

**Nucleophilic Substitution and Nucleophilic Aromatic substitution:** Stereo chemistry of  $SN_2$  and  $SN_1$  mechanisms, Neighboring Group Participation (Anchimeric assistance), NGP by O, S, N : Aromatic Nucleophilic substitution  $SN_2$  (Ar) (Addition – Elimination),  $SN_1$ (Ar) and benzyne mechanisms (Elimination - Addition); evidence for the structure of benzyne. Von Richter Sommelet-Hauser rearrangements.

**Elimination Reactions:**

Type of elimination reactions, mechanisms, Stereochemistry and Orientation, Hofmann and Saytzeff rules, Syn elimination versus anti-elimination, competition between elimination and substitution, dehydration, dehydrogenation, dehalogenation, decarboxylative eliminations and pyrolytic eliminations

**Unit-II: Stereo Chemistry-I:**

**9 Hours**

Concept and Recognition of Molecular Symmetry and Chirality. Definition and classification of Stereoisomers, Enantiomer, Diastereomer, Homomer, Epimer, Anomer, Configuration and Conformation, Configurational nomenclature: D,L and R,S nomenclature. Molecular representation of organic molecules: Fischer, Newman and Sawhorse projections and their inter-conversions. Geometrical Isomerism. Cis-trans, E, Z-and Syn and anti nomenclature, Methods of determining configuration of Geometrical isomers using physical, spectral and chemical methods, Stability, Cis-trans interconversion.

**Unit-III: Stereo Chemistry-II:**

**9 Hours**

Conformation and factors influencing on stability of Conformations; Conformational analysis of cyclic molecules - cyclobutane, cyclohexane – mono and disubstituted cyclohexanes and carbon heteroatom bonds having C–O&C–N. Prochirality and Prostereoisomerism:-Homotopic ligands and faces; enantiotopic ligands and faces; diastereotopic ligands and faces; nomenclature of enantiotopic ligands and faces(Pro-R, Pro-S, Re, Si carbonyl compounds and Alkenes)

Stereoisomerism in molecules without chiral Center Axial chirality Allenes, Alkylidene cycloalkanes, spiranes. Atropisomerism: Biphenyl derivatives, nomenclature. Planar chirality: Ansa compounds, paracyclophanes, trans- cyclooctene and Helicity.

#### **UNIT–IV Heterocyclic compounds**

**9 Hours**

Importance of heterocyclic compounds as drugs. Nomenclature of heterocyclic systems based on ring size, number and nature of hetero atoms. Chemistry of heterocyclic compounds, synthesis and reactivity of the following systems: Quinoline, Isoquinoline, Indole, Pyrazole, Imidazole, Oxazole, Isoxazole, Pyridazine, pyrimidine and Pyrazine.

#### **UNIT- V Chemistry of some typical natural products**

**9Hours**

Isolation, classification, structure elucidation, synthesis of:

**Alkaloids:** Atropine, Nicotine, and Quinine.

**Terpenoids:**  $\alpha$ -Terpeneol,  $\alpha$ -Pinene and Camphor.

#### **III. Suggested Co- Curricular Activities**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.

#### **IV. List of Textbooks:**

- 1) Advanced organic chemistry-Reaction, mechanism and structure, Jerry March, John Wiley.
- 2) Advanced organic chemistry, F.A.Carey and R.J.Sundberg, Springer, New York.
- 3) A guide book to Mechanism in organic chemistry, Peter Sykes, Longman.
- 4) Organic chemistry, I.L.Finar, Vol.I, Fifth edi . ELBS.
- 5) Organic chemistry, Hendrickson,Cram and Hammond (McGraw–Hill).

#### **V. Reference books:**

- 1) Structure and mechanism in organic chemistry, C.K.Ingold, Cornell University Press.
- 2) Principles of organic synthesis, R.O.C.Norman and J.M.Coxon, Blakie Academic & Professional.
- 3) Reaction Mechanism in Organic Chemistry, S.M.Mukherji and S.P.Singh, Macmillan.
- 4) Basic Principles of Organic Chemistry by J.B.Roberts and M. Caserio.
- 5) Stereochemistry of Organic compounds by Ernest L.Eliel, Samuel H.Wilen
- 6) Chemistry of natural products by S.V.Bhat ,B.A.Nagasampangi.
- 7) Stereochemistry of Organic compounds by D.Nasipuri.

### **ORGANIC CHEMISTRY PRACTICALS**

#### **VI. Learning Outcomes:**

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

- 1) List out, identify and handle various equipment in Chemistry lab.
- 2) Acquire skills in the separation of organic compounds in the given mixture using solvent extraction.
- 3) Determine the Melting and Boiling points of Organic compounds.
- 4) Understand the application of concepts of different organic reactions studied in the theory part of Organic chemistry.

## VII. Syllabus. *Total Hours: 30h (2h/week)*

Systematic qualitative analysis of an organic mixture containing two compounds;

Identification of method of separation and the functional group(s) present in each of them and preparation of one solid derivative for the confirmation of each of the functional group(s). Purification of derivatives- The student has to do Recrystallization to final derivatives(s) and submit the sample. If the sample is impure liquid must carry out distillation process.

## VIII. Suggested Co-Curricular Activities

**Mandatory:** (*Lab/field training of students by teacher:(lab:10+field:05)*):

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of separation of the given organic mixture, identifying and confirming the functional group followed by the preparation of recrystallized solid derivative.
- 2) **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the synthetic reactions. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork/project work Report: 05.
- 4) Suggested Format for Fieldwork/project work: Title page, student details, index page, details of place visited, observations, findings and acknowledgements.
- 5) Unit tests (IE).

## IX. Reference Books:

- 1) Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. J. Thomas, 4<sup>th</sup> & 6<sup>th</sup> Ed. (Pearson Education Asia).
- 2) Vogel's Text Book of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, 5 Ed. (Longman Scientific & Technical).

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Semester-wise Revised Syllabus under CBCS 2023-24

**Four Year - B.Sc. (Hons), Semester – VII Domain**

Subject: CHEMISTRY

**Course 16A: Physical Chemistry – I : Thermodynamics, Electrochemistry and Chemical Kinetics**

## **I. Course Learning outcomes:**

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

- 1) Understand the classical thermo dynamics, fugacity.
- 2) Describe the Electrochemical cells, Liquid junction potential. 3) Derive the Butler - Volmer equation and Ilkovic equation 4) Understand the complex reactions, chain reactions.
- 5) Demonstrate the Branching Chain Reactions, Enzyme catalysis and Photochemical equilibrium.

## **II. Syllabus**

**Total: 45 hours (3hr/Week)**

### **Unit-I: Thermodynamics:**

**9 Hours**

Classical thermodynamics - Entropy change in reversible and irreversible processes - Entropy of mixing of ideal gases - Entropy and disorder - Free energy functions - Gibbs-Helmholtz equation - Maxwell partial relations. Conditions of equilibrium and spontaneity - Free energy changes in chemical reactions, Van't Hoff reaction isotherm - Van't Hoff equation - Clausius - Clapeyron equation - partial molar quantities - Chemical potential - Gibbs- Duhem equation - partial molar volume - determination of partial molar quantities - Fugacity - Determination of fugacity - Thermodynamic derivation of Raoult's law.

### **Unit-II: Electrochemistry-1:**

**9 Hours**

Electrochemical cells - Measurement of EMF - Nernst equation - Equilibrium constant from EMF Data - pH and EMF data - Determination of solubility product from EMF measurements. Concentration cells with and without transference - Liquid junction potential and its determination - Activity and activity coefficients - Debye Huckel limiting law and its verification. Effect of dilution on equivalent conductance of electrolytes - Anomalous behavior of strong electrolytes. Debye Huckel - Onsager equation - verification and limitations - Bjerrum treatment of electrolytes.

### **Unit-III: Electro Chemistry-II:**

**9 Hours**

Reference electrode - Standard hydrogen electrode. Calomel electrode - Indicator electrodes: Metal- metal ion electrodes - Inert electrodes - Membrane electrodes - theory of glass membrane potential, potentiometric titrations, Conductometric titrations. Electrode potentials - Double layer at the interface - rate of charge transfer - Decomposition potential - Over potential - Tafel plots - Derivation of Butler- Volmer equation for one electron transfer - electro chemical potential.

### **Unit-IV :Chemical kinetics and Photochemistry:**

**9 Hours**

Branching Chain Reactions - Hydrogen-oxygen reaction - lower and upper explosion limits - Fast reactions - Study of kinetics by flow methods - Relaxation methods - Flash photolysis.

Acid base catalysis –protolytic and prototropic mechanism. Enzyme catalysis- MichelisMenten kinetics.

**Photochemistry:**Quantum yield and its determination, Actinometry, Reactions with low and high quantum yields, Photo sensitization, Exciplexes and Excimers,Kinetics of collisional quenching- Stern-Volmer equation.

### **Unit-V: Chemical kinetics - II:**

**9Hours**

Methods of deriving rate laws - complex reactions - Rate expressions for opposing, parallel and consecutive reactions involving unimolecular steps. Theories of reaction rates - collision theory- Steric factor-Activated complex theory -Thermo dynamic aspects– Unimolecular reactions- Lindemann's theory -Lindemann Hinshelwood theory. Primary and secondary salt effects. Elementary account of linear free energy relationships - Hammett equation - Chain reactions - Rate laws of H<sub>2</sub>-Br<sub>2</sub>, photochemical reaction of H<sub>2</sub> - Cl<sub>2</sub>. Decomposition of acetaldehyde and ethane- Rice-Hertzfeld mechanism.

### **III. Suggested Co- Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, discussions and debates and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field / industrial experts.

### **IV. List of Textbooks:**

- 1) Physical Chemistry P.W.Atkins, ELBS.
- 2) Chemical Kinetics -K.J.Laidler,McGraw Hill Pub.
- 3) Text Book of Physical Chemistry. Samuel Glasstone, Mcmillan Pub.
- 4) Physical Chemistry, G.W.Castellan.Narosa Publishing House

### **V. Reference books:**

- 1) Thermodynamics for Chemists.SamuelGlasstone.
- 2) Electro chemistry,SamuelGlasstone,Affiliated East West
- 3) Physical Chemistry, W.J.Moore, Prentice Hall

### **PHYSICAL CHEMISTRY PRACTICALS –I**

### **VI. Learning Outcomes:**

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

- 1)List out, identify and handle various equipment in Chemistry lab.
- 2) Learn and apply the concepts of electro chemistry in experiments.
- 3) Be familiar with electro analytical methods and techniques which study an analyte by measuring the potential ( volts) and / or current ( amperes) in an electro chemical cell containing the analyte..
- 4) Learn the procedures of preparation of standard solutions.
- 5) Acquire skills in operation and calibration of instruments..

## VII. Syllabus:

**Total Hours: 30h (2h/week)**

- 1) Conductometric titration of Strong acid versus Strong base
- 2) Dissociation constant of weak acid (CH<sub>3</sub>COOH) by conductometric method.
- 3) Conductometric titration of Weak acid vs Strong base.
- 4) Determination of cell constant
- 5) Acid-catalyzed hydrolysis of methyl acetate
- 6) Determination of partial molar volume of solute –H<sub>2</sub>O system by apparent molar volume method.

## VIII.Suggested Co-CurricularActivities

**Mandatory:***(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05):*

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of handling conductometric titrations.
- 2) **For Students:** Student shall visit a related industry / chemistry laboratory in universities/research organizations/private sector facility and observe the synthetic reactions. Write their observations and submit a hand written field work/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Field work /project work Report : 05.
- 4) Suggested Format for Field work/project work: Title page, student details, index page, details of place visited, observations, findings and acknowledgements.
- 5) Unit tests(IE).

## IX. Reference book:

- 1) Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. J. Thomas, 4<sup>th</sup> & 6<sup>th</sup> Ed. (Pearson Education Asia).

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Domain Subject: **CHEMISTRY**

## **Course 16B:** Instrumental Methods of Chemical Analysis

### I. Learning Outcomes

**By the end of the course, the students will be able to:**

- 1) Handle analytical data
- 2) Understand basic components of IR, FTIR, UV-Visible and Mass spectrometer.

- 3) Interpret of IR, FTIR, UV-visible spectra and their applications.
- 4) Understand the use of single and double beam instruments.
- 5) Learn elemental analysis, Electro analytical Methods, Radiochemical Methods, X-ray analysis and electron spectroscopy

## II. Syllabus:

**Total: 45hours(3hr/Week)**

### **Unit-I: Introduction to analytical methods of data analysis and Electroanalytical**

**Methods: [9 hours]**

Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiations.

Potentiometry & Voltammetry.

### **Unit –II: Molecular spectroscopy [9 hours]**

**Infrared spectroscopy:** Interaction of radiations with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), and advantages of Fourier-Transform Infrared (FTIR) spectroscopy.

Applications: Issues of quality assurance and quality control, special problems for portable instrumentation and rapid detection.

### **Unit- III:UV-Visible/ Near IR Spectroscopy [9hours]**

Emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and double beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time). **Unit–IV:**

### **Massspectroscopy [ 9 hours]**

Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ionson basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrapole. Resolution, time and multiple separations, detection and interpretation.

### **Unit –V: Elemental analysis [9 hours]**

**Atomic spectroscopy:** Atomic absorption, atomic emission, and atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), wavelength separation and resolution (dependence on technique), detection of radiation

(simultaneous/scanning, signal noise), interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

### III. Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

### IV. Suggested Text Books:

1. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, F.A. Jr.(2004), **Instrumental methods of analysis**, 7th edition, CBS Publishers.
2. Skoog, D.A.; Holler, F. J.; Crouch, S.(2006),**Principles of Instrumental Analysis**, Thomson Brooks/Cole.
3. Banwell, C.N. (2006),**Fundamentals of Molecular Spectroscopy**,Tata McGraw-Hill Education

### V. Reference Books:

1. Skoog, D. A.; Holler, F. J.; Crouch, S.(2006),**Principles of Instrumental Analysis**, Cengage Learning.
2. Christian, G.D.(2004),**Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.

**Course 16B:**[Instrumental Methods of Chemical Analysis-PracticalSyllabus](#)

**Total Hours: 30h(2h/week)**

### VI: Course learning outcomes

By the end of the course students will be able to

- 1) Determine the isoelectric pH of a protein
- 2) Identify the functional groups present in organic compounds
- 3) Estimate the amount of chloride and iodide present in the solution
- 4) Recognize the quality of water

### VII. Practical-Syllabus

1. Determination of the isoelectric pH of a protein.
2. Titration curve of an amino acid
3. IR absorption spectra (study of aldehydes and ketones)
4. Potentiometric titration of a chloride-iodide mixture
5. Potentiometric Titration of Metal Ions in Ethanol
6. Estimation of Alkalinity, BOD and COD

### VIII. Co-Curricular Activities:

a)Mandatory:(Lab/fieldtrainingofstudentsbyteacher:(lab:10+field:05):

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of detection of organic compounds using spectroscopic data.
2. **For Students:** Student shall visit a related industry/ chemistry laboratory in universities/research organizations/private sector facility and observes the synthetic reactions and obtain spectral data for interpretation of the synthetic compounds. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
3. Max. marks for Fieldwork/project work Report: 05.
4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
5. Unit tests (IE).

## IX. References:

1. Skoog, D. A.; Holler, F. J.; Crouch, S. (2006), **Principles of Instrumental Analysis**, Cengage Learning.
2. Christian, G.D. (2004), **Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.

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## Course 17A: Green Chemistry

### I. Learning Outcomes:

#### By the end of the course Students will be able to:

1. Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances.
2. Understand stoichiometric calculations and relate them to green chemistry metrics.
3. They will learn about atom economy and how it is different from percentage yield.
4. Learn to design safer chemical, products and processes that are less toxic, than current alternatives. Hence, they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harm you"

5. Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources, and importance led reactions in various green solvents.
6. Appreciate the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems. Thus the students are able to realize that chemistry can be used to solve rather than cause environmental problems.
7. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Success stories and real world cases also motivate them to practice green chemistry.

## **II. Syllabus: Total: 60hours(4hr/Week)**

### **Unit 1: Introduction to Green Chemistry**

**[9 hours]**

What is Green Chemistry? Some important environmental laws, pollution prevention Act of 1990, emergence of green chemistry, Need for Green Chemistry. Goals of Green Chemistry.

Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

**Unit 2: Principles of Green Chemistry and Designing a Chemical synthesis [9 hours]** Twelve principles of Green Chemistry and their explanation with examples *Special emphasis on the following:*

Prevention of Waste/ by products; maximum incorporation of the materials used in the process into the final products, Environmental impact factor, waste or pollution prevention hierarchy. Green metrics to assess greenness of a reaction, e.g. Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.

Prevention/ minimization of hazardous/ toxic products reducing toxicity. Risk = (function) hazard x exposure. Designing safer chemicals with minimum toxicity yet has the ability to perform the desired functions. Green solvents: super critical fluids with special reference to carbon dioxide, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, solvents obtained from renewable resources and how to compare greenness of solvents. Energy requirements for reactions – alternative sources of energy: use of microwaves,

Ultrasonic energy and photochemical energy. Selection of starting materials; should be renewable rather than depleting, Illustrate with few example such as biodiesel and polymers from renewable resources (such as green plastic). Avoidance of unnecessary derivatization – careful use of blocking/protecting groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of

heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

### **Unit 3: Examples of Green Synthesis/ Reactions [9 hours]**

Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). Green Reagents: Non-phosgene Isocyanate Synthesis, Selective Methylation using Dimethylcarbonate. Microwave assisted solvent free synthesis of copper phthalocyanine. Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid. And Decarboxylation reaction. Ultrasound assisted reactions:

sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)

### **Unit 4: [9 hours]**

#### **Real world case studies based on the Presidential green chemistry awards of EPA**

Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO<sub>2</sub> for precision cleaning and dry cleaning of garments. A new generation of environmentally advanced wood preservatives: Getting the chromium and Arsenic out of pressure treated wood. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn. Healthier Fats and oils by Green Chemistry:

Enzymatic Inter esterification for production of No Trans-Fats and Oils.

### **Unit 5: Future Trends in Green Chemistry [9 hours]**

Oxidation reagents and catalysts; Biomimicry and green chemistry, Biomimetic, Multifunctional Reagents; mechanochemical and solvent free synthesis of inorganic complexes; co crystal controlled solid state synthesis (C<sub>2</sub>S<sub>3</sub>); Green chemistry in sustainable development.

### **III. Suggested Co-Curricular Activities**

- 1. Training of students by related industrial experts.**
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts. **IV.**

#### **Suggested Text Books:**

1. Anastas, P.T.; Warner, J.C.(1998), **Green Chemistry, Theory and Practice**, Oxford University Press.
2. Lancaster, M.(2016), **Green Chemistry An Introductory Text**. 2nd Edition, RSC Publishing.
3. Cann, M. C. ; Connely, M. E.(2000), **Real-World cases in Green Chemistry**, American Chemical Society, Washington.
4. Matlack, A.S.(2001), **Introduction to Green Chemistry**, Marcel Dekker.
5. Alhuwalia, V. K.; Kidwai, M.R.(2005), **New Trends in Green chemistry**, Anamalaya Publishers

### **V. References:**

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**. American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K.(2013), **Green Chemistry Experiments: A monograph**, I.K.International Publishing House Pvt Ltd. New Delhi.
3. Pavia,D.L.; Lamponam, G.H.; Kriz, G.S.W. B.(2006),**Introduction to organic Laboratory Technique-A Micro-scale approach**,4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.

## **Course 17A: Green Chemistry- Practical Syllabus**

### **VI. Learning Outcomes:**

By the end of the course students will be able to

1. Synthesize nanoparticles using green methods
2. Prepare biodiesel from waste cooking oil
3. Synthesize inorganic complexes using green methods
4. Synthesize benzopinacol in the presence of sunlight

### **VII. Practical Syllabus**

**Total Hours: 30h(2h/week)**

1. Preparation and characterization of nanoparticles of CuO/ ZnO nanoparticles using plant extracts.
2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, Solubility, Combustion Test, Density, Viscosity).
3. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
4. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II).
5. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
6. Spot tests for qualitative inorganic analysis for cations and anions, and qualitative organic analysis for preliminary test and functional group analysis.

### **VIII. Co-Curricular Activities:**

**Mandatory:** *(Lab/field training of students by teacher : (lab:10+field:05):*

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of green methodologies in place of polluting solvents/chemicals
2. **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the green synthetic methods adopted in the industry. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.

3. Max. Marks for Fieldwork/project work Report:05.
4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
5. Unittests(IE).

#### **IX. References:**

1. Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. Indu Tucker Sidhwani et al. University of Delhi, Journal of Undergraduate Research and Innovation, Volume 1, Issue 1, February 2015, ISSN: 2395-2334.
2. Sidhwani, Tucker I.; Chowdhury, S. Greener alternatives to Qualitative Analysis for Cations without  $H_2S$  and other sulfur containing compounds, J. Chem. Educ. 2008, 85, 1099.
3. Sidhwani, Tucker I.; Chowdhury, S. et al., DU Journal of Undergraduate Research and Innovation, 2016, Volume 2, Issue 2, 70-79.
4. Dhingra, S., ;Angrish, C. Qualitative organic analysis: An efficient, safer, and economical approach to preliminary tests and functional group analysis. *Journal of Chemical Education*, 2011, 88(5), 649-651.

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**Course 17B: Analysis of Drugs, Foods, Dairy Products & Bio-Chemical Analysis**

**I. Learning Outcomes:**

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

1. Explain the principles of formulation and application of Drugs.
2. Acquire a critical knowledge on synthetic techniques of drugs.
3. Demonstrate the skills in analysis of **Foods, Dairy Products**.
4. Comprehended the applications of **Bio-Chemical Analysis**.
5. Acquire a critical knowledge on analysis of **Foods, Dairy Products**.

**II. Syllabus: (Total Hours: 75 hours including Teaching, Lab, Field Skills Training, Unit test etc.)**

**Total: 45 hours (3hr/Week)**

**UNIT- I**

**9 hours**

Analysis of the following drugs and pharmaceuticals preparations: (Knowledge of molecular formula, structure and analysis): Analysis of analgesics and antipyretics like aspirin and paracetamol, Analysis of antimalerials like chloroquine, Analysis of drugs in the treatment of infections and infestations: Amoxycillin, chloramphenicol, penicillin, tetracycline.

**UNIT- II**

**9 hours**

Analysis of the following drugs and pharmaceuticals preparations : (Knowledge of molecular formula, structure and analysis):

Analysis of antihistamine drugs and sedatives like: allegra, zyrtec (cetirizine), alprazolam, trazodone, lorazepam, ambien (zolpidem).

**UNIT- III**

**9 hours**

Analysis of anti epileptic and anti convulsant drugs like phenobarbital and phenacetamide. Analysis of drugs used in case of cardiovascular drugs: atenolol, norvasc (amlodipine), Analysis of lipitor (atorvastatin) a drug for the prevention of production of cholesterol.

Analysis of diuretics like: furosemide (Lasix), triamterene

Analysis of prevacid (lansoprazole) a drug used for the prevention of production of acids in stomach.

**UNIT- IV**

**10 hours**

Analysis of Milk and milk products: Acidity, total solids, fat, total nitrogen, protein, lactose, phosphate activity, casein, chloride. Analysis of food materials - Preservatives: Sodium carbonate, sodium benzoate, sorbic acid. Coloring matters – Brilliant blue FCF, fast green FCF, tartrazine, erythrosine, sunset yellow FCF.

Flavoring agents - Vanilla , diacetyl, isoamyl acetate, limonene, ethyl propionate , allyl hexanoate and Adulterants in rice and wheat, wheat floor, sago, coconut oil, coffee powder, tea powder, milk.

#### **UNIT-V**

**8 hours**

Clinical analysis of blood: Composition of blood,clinical analysis, trace elements in the body. Estimation of blood cholesterol, glucose,enzymes, RBC&WBC,Blood gas analyser.

### **III. Suggested Co-Curricular Activities**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits of related Industries/firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.

### **IV. Text Books:**

1. Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
2. Foye's Principles of Medicinal Chemistry. 3. Burger's Medicinal Chemistry, Vol I to IV.
4. Introduction to principles of drug design- Smith and Williams.

### **V. References Books:**

1. Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
2. Foye's Principles of Medicinal Chemistry. 3. Burger's Medicinal Chemistry, Vol I to IV.
4. Introduction to principles of drug design- Smith and Williams.
5. Remington's Pharmaceutical Sciences. 6. Martindale's extra pharmacopoeia.
7. Organic Chemistry by I.L. Finar, Vol. II.
8. The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
9. Text book of practical organic chemistry- A.I.Vogel.

### **Course 17B. [Analysis of Drugs, Foods, Dairy Products & Bio-Chemical Analysis - Practical Syllabus](#)**

### **VI. Learning Outcomes:**

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

1. Develop comprehensive product development programs to meet new product criteria and timing.
2. Acquire skills in the Analysis of Drugs, foods and Dairy Products.
3. Demonstrate proficiency in the experimental techniques of biomedical chemical
4. Carry out food testing with the knowledge of foods.
5. Learn the procedure of synthesis of drugs.
6. Critically develop, apply, report, interpret and reflect on strategies for collecting data in the lab and field.

## VII. Practical (Laboratory) Syllabus: **Total/Hours: 30h(2h/week)**

1. Preparation of Aspirin
2. Preparation of Paracetamol
3. Preparation of Acetanilide
4. Preparation of Barbituric Acid
5. Preparation of Phenyl Azo  $\beta$ -naphthol

## VIII. References Books:

1. Introduction to principles of drug design- Smith and Williams.
2. Remington's Pharmaceutical Sciences.
3. Martindale's extra pharmacopoeia.
4. Organic Chemistry by I.L. Finar, Vol. II.
5. The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
6. Text book of practical organic chemistry- A.I. Vogel.

## IX. Co-Curricular Activities

**Mandatory:(Lab/field training of students by teacher:(lab:10+field:05):**

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of comprehensive product development programs to meet new product criteria and timing. Acquire skills in the preparation of Drugs, foods and Dairy Products, carry out food testing with the knowledge of testing food adulteration and learn the procedure of synthesis of drugs.
  2. **For Students:** Students shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the preparation of Cosmeceuticals and Pharmaceutical. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
    - a). Max marks for Fieldwork/project work Report: 05.
    - b). Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
- c). Unit tests (IE).

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**Course 18A:** Polymer Chemistry

**I. Course Learning Outcomes**

**By the end of this course, students will be able to:**

1. Know about history of polymeric materials and their classification
2. Learn about different mechanisms of polymerization and polymerization techniques
3. Evaluate kinetic chain length of polymers based on their mechanism
4. Differentiate between polymers and copolymers
5. Learn about different methods of finding out average molecular weight of polymers
6. Differentiate between glass transition temperature ( $T_g$ ) and crystalline melting point ( $T_m$ )
7. Determine  $T_g$  and  $T_m$
8. Know about solid and solution properties of polymers
9. Learn properties and applications of various useful polymers in our daily life.

**II. Syllabus:**

**Total: 45 hours(3hr/Week)**

**Unit-1**

**History of polymeric materials and functionality and its importance** [9 hours]

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

**Unit-II**

**Kinetics of Polymerization** [9 hours]

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

**Unit-III**

**Determination of molecular weight of polymers and crystallinity** [9 hours]

( $M_n$ ,  $M_w$ , etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Poly dispersity index.

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

**Unit-IV**

**Glass transition temperature (T<sub>g</sub>) and Polymer Solution** [9 hours]

Free volume theory, WLF equation, Factors affecting glass transition temperature (T<sub>g</sub>).

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

**Unit-V**

**Properties of Polymers** [9 hours]

(Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: poly olefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [poly acetylene, poly aniline, poly(p-phenylene sulphide poly pyrrole, poly thiophene)].

**III. Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

**IV. Suggested Text Books:**

1. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction*, Marcel Dekker, Inc. New York, 1981.
2. G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.
3. F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
4. P. Ghosh: *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
5. R.W. Lenz: *Organic Chemistry of Synthetic High Polymers*. Interscience Publishers, New York, 1967.

**V. Refernces:**

1. Allcock, H.R.; ; Lampe, F. W.; Mark, J. E.(2003),**Contemporary Polymer Chemistry**, Prentice-Hall.
2. Fried, J.R. (2003), **Polymer Science and Technology**, Prentice-Hall.

## **Course 18A:**[Polymer Chemistry- Practical Syllabus](#)

### **VI.Learning Outcomes:**

By the end of the course students will be able to

1. Determine the molecular weight of a polymer by viscometric studies
2. Prepare urea formaldehyde polymer
3. Determine the molecular weight by end group analysis

### **VII. Practical Syllabus**

**Total Hours: 30h(2h/week)**

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Determination of molecular weight by viscometry: Poly vinyl propylidene (PVP) in water
3. Determination of molecular weight by end group analysis
4. Preparation of urea-formaldehyde resin
5. Precipitation polymerization of acrylonitrile
6. Redox polymerization of acrylamide

### **VIII. Co-Curricular Activities:**

**Mandatory:***(Lab/field training of students by teacher : (lab:10+field:05):*

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of preparation of polymers.
2. **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the preparation steps of polymers and quality polymer formed using various techniques. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
3. Max. Marks for Fieldwork/project work Report:05.
4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
5. Unit tests(IE).

## IX. References:

1. Munk, P.; Aminabhavi, T. M. (2002), **Introduction to Macromolecular Science**, John Wiley & Sons.
2. Sperling, L.H.(2005),**Introduction to Physical Polymer Science**, John Wiley & Sons

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### **Course 18B.**[Industrial Chemicals and Environment](#)

#### **I.LearningOutcomes:**

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

1. Identify the importance of Manufacture of *Inorganic Chemicals*
2. Acquire knowledge on production, uses, storage and hazards of *Industrial Gases*.
3. Understand the importance of **Environment**.
4. Understanding about water pollution and its effects.
5. Acquire knowledge on **Energy and its effects on Environment**

## II. Syllabus: (Total Hours: 75 including Teaching, Lab, Field Skills Training, Unit test etc.)

Total theory: 45 hours (3hrs/Week)

### Unit-I 9 Hours

**Inorganic Chemicals:** Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

### Unit-II 9 Hours

**Industrial Gases:** Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene **Industrial Metallurgy:** Preparation of metals (ferrous and nonferrous) and ultra pure metals for semiconductor technology.

### Unit-III

9 hours

#### Air pollution

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by  $\text{SO}_2$ ,  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{H}_2\text{S}$  and other foul smelling gases. Methods of estimation of  $\text{CO}$ ,  $\text{NO}_x$ ,  $\text{SO}_x$  and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluoro carbons and Halogens, removal of sulphur from coal. Control of particulates.

### Unit-IV

9 hours

**Water Pollution:** Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc.

### Unit-V

#### Energy & Environment

9 hours

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion/Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis: Introduction to biocatalysis: Importance in — Green Chemistry and Chemical Industry.

## III. Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of related Industries/firms, research organizations etc.

4. Invited lectures and presentations on related topics by field/industrial experts.

#### IV. Text Books:

1. J.A.Kent: Riegel's *Hand book of Industrial Chemistry*, CBS Publishers, New Delhi.
2. S.S.Dara: *A Text book of Engineering Chemistry*, S.Chand & Company Ltd. New Delhi.
3. K.De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
4. E.Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.

#### V. References Books:

1. E.Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J.A.Kent: Riegel's *Hand book of Industrial Chemistry*, CBS Publishers, New Delhi.
4. S.S.Dara: *A Text book of Engineering Chemistry*, S.Chand & Company Ltd. New Delhi.
5. K.De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S.M.Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
7. S.E.Manahan, *Environmental Chemistry*, CRC Press (2005).
8. G.T.Miller, *Environmental Science* 11th edition. Brooks/Cole (2006).
9. A.Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

#### Course 18B: Industrial Chemicals & Environment- Practical Syllabus VI.

##### Learning Outcomes:

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

1. Perform Determination of DO, COD and BOD
2. Learn the procedure for measurement of chloride, sulphate and salinity of water
3. Estimation of total alkalinity of water
4. Acquire skills in determination of dissolved gases like O<sub>2</sub>, CO<sub>2</sub>, SPM etc.

##### VII. Practical (Laboratory) Syllabus:

Total hours: 30h (2h/week)

1. Determination of Dissolved Oxygen (DO) in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO<sub>3</sub> and potassium chromate).
6. Estimation of total alkalinity of water samples (CO<sub>3</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>) using double titration method.
7. Measurement of dissolved CO<sub>2</sub>.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/boric acid.

##### VIII. Lab References:

1. E.Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. J.A.Kent: Riegel's *Hand book of Industrial Chemistry*, CBS Publishers, New Delhi.

4. S.S.Dara: *A Text book of Engineering Chemistry*, S.Chand & Company Ltd, New Delhi.
5. K.De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
6. S.M.Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

### IX. Co-Curricular Activities

**Mandatory:** (Lab/field training of students by teacher: (lab:10+field:05):

5. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills in determination of DO, COD, BOD, CO<sub>2</sub>, SPM etc. Learn the procedure for measurement of chloride, sulphate and salinity of water, total alkalinity of water
6. **For Students:** Students shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the determination of DO, COD, BOD, CO<sub>2</sub>, SPM etc. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
  - a. Max marks for Fieldwork/project work Report: 05.
  - b. Suggested Format for Fieldwork/project work: *Title page, student details, index page, detail of place visited, observations, findings, and acknowledgements.*
  - c. Unit tests (IE).

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**Course 20A: Inorganic Chemistry-II: Metal clusters, Electronic spectra of Complex compounds and Bio-inorganic chemistry**

**I. Course Learning outcomes:**

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

- 1) Understand the study of age compounds of oxygen, phosphorous and sulphur..
- 2) Explain the various metal clusters and metal  $\pi$  complexes.
- 3) Describe the reactions of organo metallic compounds and its applications.
- 4) Understand the reaction mechanism in transition metal complexes.
- 5) Demonstrate the Orgel diagrams and electronic spectra of transition metal complexes.
- 6) Discuss structure and functions of hemoglobin, myoglobin and vitamin B12, photochemical laws.

**II. Syllabus Total: 45hours(3hr/Week)**

**Unit-I: Non-metal cages and metal clusters:**

**9Hours**

Structure and bonding in phosphorous- oxygen, phosphorous -Sulphur cages; structure and bonding in higher boranes with (special referenceto  $B_{12}$  icosahedra). Carboranes, metalloboranes, metallocarboranes. Classification- LNCs and HNCs, Isoelectronic and Isolobal relationships, electron counting rules: Wade's and Lauher's rules. M-M multiple bonding; preparation ,structure and bonding in dinuclear  $[Re_2Cl_8]^{2-}$  ion, trinuclear  $[Re_3Cl_9]$ , tetranuclear  $W_4(OR)_{16}$ , hexanuclear  $[Mo_6Cl_8]^{4+}$  and  $[Nb_6Cl_{12}]^{2-}$ .

**Unit-II: Organo metallic chemistry of transition metals:**

**9Hours**

Classification and electron counting rules, hapticity, synthesis, structure and bonding of Ferrocene, dibenzene chromium, cycloheptatriene and tropylium complexes of transition metals. Reactions of organo metallic compounds- oxidative addition, reductive elimination, insertion and elimination. Applications of organo metallic compounds- Catalytic hydrogenation, Hydro formylation.

**Unit-III: Reaction mechanism of transition metal complexes:**

**9Hours**

Kinetics of octahedral substitution, acid hydrolysis, base hydrolysis - conjugate base (CB) mechanism. Direct and indirect evidences in favour of CB mechanism. Anation reactions. Reactions without metal-ligand bond cleavage. Factors affecting the substitution reactions in octahedral complexes. Trans effect on substitution reactions in square planar complexes. Mechanism of redox reactions, outer sphere mechanism, cross reactions and Marcus – Hush equation, inner sphere mechanism.

**Unit-IV: Term symbols and Electronic spectra:**

**9Hours**

Term symbols and their derivation. Microstates, Hunds rules to predict ground terms and ground states. List of ground energy and higher energy terms from  $d^1$  to  $d^9$  configurations;

**Electronic spectra of transition metal complexes:** Spectroscopic terms. Selection rules, Slater-Condon parameters, Racah parameters, Term separation energies for  $d^n$  configurations. Correlation diagrams and Orgel diagrams. Tanabe-Sugano diagrams for  $d^1$  to  $d^9$  configurations. Calculations of  $Dq$ ,  $B$  and  $\beta$  parameters. Charge transfer spectra.

**Unit-V: Bio-inorganic chemistry and Magnetic properties of complexes: 9 Hours Bio-inorganic chemistry:**

Storage and transport of dioxygen by Hemoglobin and Myoglobin, Chlorophyll, Vitamin  $B_{12}$  and its importance.

**Magnetic properties of transition metal complexes:**

Orbital and spin contribution, spin-orbit coupling and magnetic moments. Types of magnetism, factors affecting on Paramagnetism, Dia, ferro and Antimagnetism.

**III. Suggested Co-Curricular Activities**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, discussions, debates and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts

**IV. List of Textbooks:**

- 1) Inorganic Chemistry by Huheey, Harper and Row.
- 2) Concise inorganic chemistry by J.D. Lee, ELBS.
- 3) Inorganic chemistry, K.F. Purcell and J.C. Kotz, Holt Saunders international
- 4) Organometallic chemistry by R.C. Mehrotra and A. Singh, New Age International.
- 5) Advanced Inorganic Chemistry by Cotton and Wilkinson, Wiley Eastern

**V. Reference books:**

- 1) Inorganic reaction mechanism by Basolo and Pearson, Wiley Eastern
- 2) Bioinorganic Chemistry by K. Hussain Reddy
- 3) Biological Aspects of inorganic chemistry by A.W. Addison, W.R. Cullen, D. Dolphin and G.J. James. Wiley Interscience.
- 4) Photochemistry of coordination compounds by V. Balzani and V. Carassiti. Academic Press.
- 5) Text book of Coordination chemistry by K. Soma Sekhara Rao and K.N.K. Vani, Kalyani Publishers.

**INORGANIC CHEMISTRY PRACTICALS –II**

**VI. Learning Outcomes:**

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

- 1) List out, identify and handle various equipment in Chemistry lab.

- 2) Learn the concepts and procedures of preparation of standard solutions, primary and secondary standards.
- 3) Demonstrate skills in Volumetric and gravimetric determinations.
- 4) Acquire skills in standardizing and determination of different metal ions.
- 5) Understand and explain the volumetric analysis based on fundamental concepts learnt in ionic equilibria.

## VII. Practical Syllabus:

**Total Hours: 30h (2h/week)**

### Quantitative analysis - Volumetric:

- 1) Determination of Ferric iron by photochemical reduction
- 2) Determination of Nickel by EDTA
- 3) Determination of Calcium and Magnesium in a mixture by EDTA
- 4) Determination of Ferrocyanide by Ceric sulphate
- 5) Determination of Copper(II) in presence of iron(III) **Gravimetric:**
  - 1) Determination of Zinc as Zinc pyrophosphate
  - 2) Determination of Nickel from a mixture of Copper and Nickel.

## VIII. Suggested Co-Curricular Activities

**Mandatory:** *(Lab/field training of students by teacher: (lab:10+field:05):*

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of determination of cations by volumetric and gravimetric determinations.
- 2) **For Students:** Student shall visit a related industry/ chemistry laboratory in universities/ research organizations/private sector facility and observe the synthetic reactions. Write their observations and submit a hand written field work/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Field work / project work Report: 05.
- 4) Suggested Format for Fieldwork/project work: Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.
- 5) Unit tests (IE).

## IX. Reference books:

- 1) Vogel's text book of quantitative chemical analysis, 5<sup>th</sup> edition by G.H. Jeffery et al.

A.P. State Council of Higher Education  
Semester-wise Revised Syllabus under CBCS 2023-24  
Four Year - B.Sc. (Hons), Semester – VII  
Domain Subject: **CHEMISTRY**

## Course 20B: Organo Metallic Chemistry

### I. Learning Outcomes:

**By the end of this course, students will be able to**

1. Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
  2. Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
  3. Identify important structural features of the various haptic metal complexes
  4. Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst,
  5. Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process
  6. Understand the importance of organometallic compounds in the synthesis of organic compounds
- II. Syllabus:**

**Total: 45hours(3hr/Week)**

### **Unit-I**

#### **Mono, Di, haptic Complexes**

**[9 hours]**

Nomenclature and Classification based on the number of Coordinated Carbons (hapticity) and number of electrons donated by the Ligand. 16 and 18 electron rules. Electron counting covalent and ionic models.  $\sigma$  Complexes : General methods of Preparation – Bonding of Ligand to Metal :  $\alpha$  and  $\beta$  Interaction and agostic interaction – Stability and decomposition pathways –  $\sigma$ 1 Complexes – Tertiary Phosphine – Transition Metal Alkyl and Aryl Complexes of Pt – Ortho-effect – Bonding in Metal – Carbene and Carbyne Complexes.  $\sigma$ 2 – Complexes: General methods of preparation of Metal – Alkene Complexes – Structure and Bonding in  $\sigma$ 2 Complexes.

### **Unit-II**

#### **Tri, tetra and pentahaptic Complexes**

**[9 hours]**

$\sigma$ 3 - Complexes: Metal-Allyl Complexes – General Preparative Routes – Structure and Bonding in  $\sigma$ 3 Allyl Complexes – Fluxionality.  $\sigma$ 4 Complexes: Structure and Bonding in  $\sigma$ 4 Complexes – Butadiene and Cyclo butadiene Complexes.  $\sigma$ 5 – Complexes: General methods of Preparation – Bis ( $\sigma$ 5-cyclopentadienyl) metal complexes (Metallocenes) – Ferrocene: Structure and Bonding – Reactions of Ferrocene – Mechanism of Electrophilic substitution – Friedel Crafts acylation, alkylation, nitration.

### **Unit-III**

#### **Hexa, Hepta and Octahaptic Complexes [9 hours]**

$\sigma$ 6 Complexes : Metal – Arene Complexes – Dibenzenechromium – Preparation, Structure and Bonding in Bis(arene)-Metal Complexes – Reactions.  $\sigma$ 7 Complexes: Preparation, Structure and Reactions of  $\sigma$ 7  $C_7H_7$  Complexes.  $\sigma$ 8 Complexes:  $C_8H_8$  as a Ligand – Cyclooctatetraene Complexes – Preparation, Structure and Bonding in Uranocene

### **Unit-IV**

#### **Catalysis by Organometallic Compounds [9 hours]**

General principles of catalysis, properties of catalysts, homogeneous and heterogeneous catalysis

(Catalytic steps, examples and industrial applications), deactivation and regeneration of catalysts, catalytic poison, promoter.

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Synthetic gasoline (Fischer Tropsch reaction)
3. Polymerisation of ethene using Ziegler-Natta catalyst

### **Unit-V**

#### **Organometallic Reagents in Organic synthesis [9 hours]**

Preparation and application of the following in organic synthesis: 1) Organolithium 2) Organocopper reagents 3) Organoboranes in C-C bond formation 4) Organosilicon reagents: reactions involving  $\beta$ -carbocations and  $\alpha$ -carbanions, utility of trimethylsilyl halides, cyanides and triflates.

### **III. Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of industries, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

### **IV. Suggested Text Books:**

1. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry 2nd Ed.**, Oxford University Press.
2. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
3. Cotton, F.A.; Wilkinson, G.; Gaus, P.L. **Basic Inorganic Chemistry**, 3rd Edition, Wiley India.
4. Powell, P. (1988), **Principles of Organometallic Chemistry**, Chapman and Hall. **V.**

### **References:**

1. Organometallics-A Concise Introduction, Ch. Eischenbroich and Salzer-VCH
2. Organotransition Metal Chemistry Fundamental Concepts and Applications, John Akio Yamamoto, Wiley & Sons.
3. Basic organometallic Chemistry, B.D. Gupta / A. J. Elias

4.Greenwood, N.N.; Earnshaw, A.(1997), **Chemistry of the Elements**, 2nd Edition, Elsevier(Ziegler Natta Catalyst and Equilibria in Grignard Solution)

## **Course 20B: Organo Metallic Chemistry-Practical Syllabus**

### **VI. Learning Outcomes**

**By the end of the course students will be able to**

1. Synthesize inorganic complexes using monodentate ligands
2. Prepare Cis complexes using bi dentate ligands
3. Prepare Trans Complexes using bi dentate ligands
4. Distinguish Cis and Trans compounds

### **VII. Practical Syllabus:**

**Total Hours: 30h(2h/week)**

1. TetraammineCopper (II) Sulphate monohydrate
2. Potassium tris oxalate Ferrate (III) Tri hydrate
3. Hexaammine Nickel (II) Chloride
4. Preparation of Cis bis (glycinate) Copper (II) monohydrate
- 5.Preparation of Transbis (glycinate) Copper (II) monohydrate
6. Synthesis of tris (acetyl acetonato) Manganese (III)

### **VIII. Co-Curricular Activities:**

**Mandatory:***(Lab/field training of students by teacher :(lab:10+field:05):*

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of preparation and identification of complexes
2. **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the synthesis of inorganic metal complexes and analyze it using IR spectral data. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
3. Max. Marks for Fieldwork/project work Report:05.

4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*

5. Unit tests(IE).

### **IX. References:**

1. Advanced Practical Chemistry, J. Singh, R.K.P.,Singh, etc. Pragati Edition
2. R.G. Charles, Inorg. Synth. 7 (1963) 183

3. F. Basolo and R.g. Pearson, Mechanisms of Inorganic reactions, 2 nd Edition. Pearson

A.P. State Council of Higher Education

Semester-wise Revised Syllabus under CBCS 2023-24

**Four Year - B.Sc. (Hons), Semester – VIII**

Domain Subject: CHEMISTRY

**Course 21A: Organic Chemistry: Modern Organic synthesis and Natural products**

**I. Course Learning outcomes:**

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

- 1) Understand various types of reaction intermediates and the bonding present in various organic compounds.
- 2) Explain how to protect various functional groups in organic synthesis.
- 3) Describe the mode of addition reactions by electrophile and nucleophiles.
- 4) Discuss mechanisms of named reactions and their applications in organic synthesis.
- 5) Know about the importance of flavones, flavonoids and hormones.

**II.**

**Syllabus: Total: 45 hours(3hr/Week)**

**UNIT – I Reactive intermediates, Reactive Species and Protecting groups: 9 hours**

**Reactive intermediates** :Generation, Structure, Stability, Detection and Reactivity of Carbocations, Carbanions, Free radicals, Carbenes, Nitrenes and Arynes.

**Reactive Species:** Generation and reactivity of Electrophiles, Nucleophiles, Dienophiles, Ylids, Enophiles.

**Protecting groups:** Protection of carbonyl, Hydroxyl, carboxylic acid and amine groups.

**UNIT-II Addition Reactions**

**9 Hours**

**Addition to Carbon – Carbon Multiple Bonds:** Mechanistic and stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, region and chemo selectivity, orientation and reactivity, Hydrogenation of double and triple bonds, hydrogenation of aromatic rings, Hydroboration.

**Addition to Carbon - Hetero Multiple Bonds:** Steric course of addition reactions to C=O and C=N, , Knoevenagel, Claisen- Schmidt, Dieckman and Stobbe condensations, Wittig, Grignard, Mannich and Michael reaction.

**UNIT-III Molecular Rearrangements**

**9 Hours**

Types of molecular rearrangements, migratory aptitude;

Rearrangements to electron deficient carbon: Wagner-Meerwein, Dienone-Phenol, ArndtEistertsynthesis;

Rearrangements to electron deficient nitrogen: Beckmann, Hofmann, Schmidt rearrangements;

Rearrangements to electron deficient oxygen: Baeyer-villiger, Benzil-Benzilic acid and Favorskii rearrangements.

**UNIT-IV: Steroid hormones**

**9Hours**

Nomenclature, basic skeleton, Diel's hydrocarbon and it's stereochemistry. Isolation, structure determination and synthesis of androsterone, testosterone, oestrone and progesterone.

**UNIT–V: Flavonoids and Isoflavonoids:****9 Hours**

Nomenclature and general methods of structure determination, Isolation, structure elucidation and synthesis of Kaempferol, Quercetin, Cyanidin, Genestein, Butein and Daidzein. Biosynthesis of flavonoids and Isoflavonoids.

**III. Suggested Co- curricular activities**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars, discussions and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts

**IV. List of Text books :**

- 1) Advanced Organic Chemistry: Reactions Mechanisms and Structure by JerryMarch, Mc.GrawHill and Kogakush.
- 2) Organic Chemistry Vol.I(SixthEd )andVol.II(Fifth Ed.) by ILFinar ELBS.
- 3) Organic Chemistry (fifthEd) by Morrison and Boyd, PHI, India.
- 4) Organic Chemistry (fifthedition) by Francis A.Carey Tata Mc Graw Hill publishing Company Limited, New Delhi.
- 5) Chemistry of natural products by S.V.Bhat, B.A.Nagasampangi

**V. Reference Books:**

- 1) Reaction Mechanism in Organic Chemistry by Mukherjee Singh.
- 2) A guide book to mechanism in Organic Chemistry by Peter Sykes, ELBS.
- 3) Chemistry of Natural products by R.S.Kalsi, Kalyani Publishers.1983.

**ORGANIC CHEMISTRY PRACTICALS –II****VI. Learning Outcomes:**

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

- 1)List out, identify and handle various equipment in Chemistry lab.
- 2) Learn the concepts and procedures of handling chemical reagents appropriately.
- 3) Demonstrate skills to perform reflux, distillation, recrystallisation and vacuum filtration.
- 4) Calculate theoretical yield and percent yield. .
- 5) Dispose chemicals in a safe and responsible manner.

**VII. Syllabus:****Total Hours: 30h (2h/week)**

Preparation, recrystallization, and determination of melting point & yield of the following compounds:

- 1) Aspirin
- 2) Nerolin
- 3) Chalcone
- 4) p-Nitro acetanilide
- 5) 2,4,6- Tribromoaniline

- 6) m-Dinitrobenzene
- 7) Phthalimide
- 8) Diels-Alder adduct.

### VIII. Suggested Co-Curricular Activities

**Mandatory:** (Lab/field training of student by teacher: (lab:10+field:05):

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of organic synthesis and recrystallization of the organic compound
- 2) **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the synthetic reactions. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork /project work Report: 05.
- 4) Suggested Format for Fieldwork/project work: Title page, student details, index page, details of place visited, observations, findings and acknowledgements.
- 5) Unit tests (IE).

### IX. Reference Books:

- 1) Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. J. Thomas, 4<sup>th</sup> & 6<sup>th</sup> Ed. (Pearson Education Asia).
  - 2) Vogel's Text Book of Practical Organic Chemistry, B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, 5 Ed. (Longman Scientific & Technical)
- A.P. State Council of Higher Education  
Semester-wise Revised Syllabus under CBCS 2023-24  
Four Year - B.Sc. (Hons), Semester – VII  
Domain Subject: **CHEMISTRY**

### **Course 21B:** Chemistry of Natural Products

#### I. Course learning Outcomes

**By the end of the course students will be able to:**

Understand isolation, purification and characterization of simple chemical constituents from the natural source

1. Learn the different types of alkaloids and their chemistry
2. To know the classification of terpenoids, isoprene rule, structures and their natural sources.
3. Learn advanced methods of structural elucidation of compounds of natural origin
4. Understand isolation, purification, chemical constituents from the natural source
5. To

know the structure characterization and synthesis of steroids **II. Syllabus:**

**Total: 45 hours (3hr/Week)**

## Unit I:

### Alkaloids

[9 hours]

Introduction, general methods for the elucidation of the structure, breaking into small fragments, determination of structure of fragments. Type of linkage, functional nature of oxygen, zwitter ion method to know number of –OH groups, C=O group, –COOH group – OCH<sub>3</sub> (Ziesel's method). Detection of N atom, Detection of –N-CH<sub>3</sub> group. Herzig–Meyer method to recognize heterogeneous system. Hofmann exhaustive methylation.

Emde's degradation, Von-Braundegradation, reductive degradation, Alkali fusion, oxidation, dehydrogenation.

### Unit - II: Structure and synthesis [9 hours]

1. Phenyl ethyl amine group alkaloids (adrenaline)
2. Piperidine group alkaloids (piperine)
3. Pyridine group alkaloids (coniine)

## Unit- III

### Terpenoids

[9 hours]

Isoprene rule, special isoprene rule, classification. General methods of the determination of structure. Nature of Oxygen, number of alkyl groups (Kuhn-roth method). Unsaturation detection, reduction (NOCl), dehydrogenation, oxidative degradation, ozonolysis, H<sub>2</sub>O<sub>2</sub>,

Baeyer's reagent, NaOX, HNO<sub>3</sub>, dehydration–ZnCl<sub>2</sub>, H<sub>2</sub>SO<sub>4</sub>.

Catalytic hydrogenation, Grignard reaction, Reformatsky reaction.

### Unit-IV Structure and synthesis

[9 hours]

Mono terpenoids (acyclic)-Citral–structure and synthesis. Monocyclic mono terpenoids:

α -Terpeniol, Menthol, Limonine –Structure and Synthesis

## Unit-V

### Steroids [9 hours]

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol (Synthesis not required), Bio Synthesis of Steroids. Chemistry and synthesis of oestrone, progesterone, androsterone, testosterone.

## III. Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

#### **IV. Suggested Text Books:**

1. Some Modern methods of Organic Synthesis W. Carithers, Cambridge University Press, Cambridge.
2. Organic Chemistry: Stereochemistry and the Chemistry of Natural Products.-I.L. Finar, Pearson Education, Asia
3. Organic Chemistry, Morrison and Boyd, Pearson, 7<sup>th</sup> Edition
4. Organic Chemistry, Solmons and Fryhle, Willy Student Edition
5. Organic Chemistry a Lab Manual, Piva, Lampman, Engel. Cengage Learning India

#### **V. References:**

1. The terpenoids by Simonsen
- 2) The steroids by Shoppee
- 3) Chemistry of Carbon compounds by Rodd

### **Course 21B: Chemistry of Natural Products- Practical Syllabus**

#### **VI. Learning outcomes:**

By the end of the course students will be able to:

1. Separate the natural products using chromatographic techniques
2. Identify the alkaloids present in extracted natural products
3. Identify the terpenes present in plant extracts
4. Identify the steroids present in plant extracts
5. Identify the phenolic groups present in natural products

#### **VII. Practical Syllabus *Total Hours: 30h(2h/week)***

1. Separation of natural products using column chromatography

2. Identification of alkaloids in any three plant extracts
3. Identification of terpenes in any three plant extracts
4. Identification of diterpenoids in any three plant extracts
5. Identification of Steroids in any three plant extracts
6. Identification of phenolic groups in three plant extracts

### **VIII. Co-Curricular Activities:**

**Mandatory:** *(Lab/field training of students by teacher : (lab:10+field:05):*

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of analyzing organic compounds using spectroscopic data.
2. **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the separation of natural products obtaining spectral data and analyzing the functional groups and type of natural product. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
3. Max. Marks for Fieldwork/project work Report: 05.
4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
5. Unit tests (IE).

### **IX. References:**

- 1) The terpenoids by Simonsen
- 2) The steroids by Shoppee
- 3) Chemistry of Carbon compounds by Rodd

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Semester-wise Revised Syllabus under CBCS 2023-24

**Four Year - B.Sc. (Hons), Semester – VIII**

Domain Subject: CHEMISTRY

**Course 22A: Physical Chemistry: Quantum and Molecular Spectroscopy**

**I. Course Learning outcomes:**

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

- 1) Learn the basic non-relativistic quantum mechanics.
- 2) Understand the time-dependent and time-independent Schrödinger equation.
- 3) Describe the principles and theories of rotational, vibrational and vibrational spectroscopy methods.
- 4) Interpret the molecular spectra and find molecular properties from molecular spectra.

**II.**

**Syllabus: Total: 45 hours(3hr/Week)**

**Unit – I Basic Quantum Chemistry-I- :**

**9 Hours**

Wave equation - interpretation of wave function-properties of wave function normalization and orthogonalisation, Operators- linear and non-linear-commutators of operators. Postulates of quantum mechanics; setting up of operators to observables; Hermitian operator- Eigen values and Eigen functions of Hermitian

operator; Expansion theorems. Eigen functions of commuting operators-significance. Simultaneous measurement of properties and the uncertainty principle.

**UNIT-II Basic Quantum Chemistry-II- :**

**9 Hours**

Wave mechanics of simple systems with constant potential energy, particle in one dimensional box- factors influencing color transition- dipole integral, Symmetry arguments in deriving the selection rules, the concept of tunneling- particle in three dimensional box. Calculations using wave functions of the particle in a box Orthogonality, measurability of energy, position and momentum, average values and probabilities. Rigid rotor, Wave mechanics of systems with variable potential energy simple harmonic oscillator- solution of wave equation- selection rules.

**UNIT-III Fundamentals of Molecular Spectroscopy-I:**

**9 Hours**

Microwave and IR- Spectroscopy- Rotational spectra of diatomic molecules - Rigid rotor - Selection rules- Calculations of bond length- Isotopic effect, Second order stark effect and its applications. Infrared spectra of diatomic molecules- harmonic and anharmonic oscillators - Selection rules- Overtones- Combination bands- Calculation of force constant, anharmonicity constant and zero point energy. Fermi resonance, simultaneous vibrational - rotational spectra of diatomic molecules.

**UNIT- IV. Fundamentals of Molecular Spectroscopy - II :**

**9Hours**

Raman and Electronic Spectra- Classical and quantum mechanical explanations-

Rotational Raman and Vibrational Raman spectra. Electronic spectra of diatomic

molecules- Vibrational Coarse structure- intensities of spectral lines- Franck-Condon principle- applications, Rotational Fine structure- band head and band shading. Charge transfer spectra.

**UNIT- V Introduction to computer programming- FORTRAN 77:**

**9 Hours**

Basic structures and functioning of computer with P.C. as an illustrative example- Main memory- Secondary storage memory- input/output devices- computer languages- operating systems- principles of algorithms-and flow charts-constants and variables- Arithmetic expressions- Arithmetic statements- Replacement statement- IF statement- logical IF and BLOCK IF statements- GOTO statements-subscripted variable and DIMENSION statement. DO statement- Rules for DO statement- Functions and subroutines- Development of FORTRAN statements for simple formulae in chemistry such as Vander Waals equation- pH of a solution- First order rate equation- Cell constant Electrode potential. Flow charts and computer programs for Program for the calculation of Cell Constant, Specific Conductance and Equivalence. Rate Constant of First order reaction or Beer's law by linear least square method. Hydrogen ion concentration of a strong acid solution/Quadratic equation. Solution for Vander Waals equation or Hydrogen ion concentration of a monoprotic weak acid Standard deviation and Variance of univariant data.

**III. Suggested Co – curricular activities :**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits to laboratories, firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts

#### **IV. List of Text books:**

- 1) Fundamentals of Molecular spectroscopy: by C.N. Banwell
- 2) Molecular spectroscopy: by B.K.Sharma
- 3) Molecular spectroscopy: by Aruldas
- 4) Introductory quantum mechanics: by A.K. Chandra

#### **V. Reference books:**

- 1) Quantum chemistry: by R.K. Prasad
- 2) Principles of computer programming(FORTRAN 77 IBM PC): by V.Rajaraman
- 3)Basics of computers for chemists: by P.C. Jurs

### **PHYSICAL CHEMISTRY PRACTICALS –II**

#### **VI. Learning Outcomes:**

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

- 1) List out, identify and handle various equipment in Chemistry lab.
- 2) Learn and apply the concepts of electro chemistry in experiments.
- 3) Be familiar with electro analytical methods and techniques which study an analyte by measuring the potential (volts) and / or current (amperes) in an electro chemical cell containing the analyte.
- 4) Learn the procedures of preparation of standard solutions.
- 5) Acquire skills in operation and calibration of instruments.

#### **VII. Syllabus:**

**Total Hours: 30h (2h/week)**

- 1) Titration of mixture Strong acid and weak acid versus Strong base by conductometry.
- 2) Titration of Strong acid Vs Strong Base – pH – metry.
- 3) Titration of mixture of (NaHCO<sub>3</sub> + Na<sub>2</sub>CO<sub>3</sub>) Vs HCl – pH- metry.
- 4) Titration of Strong acid Vs Strong Base using Quinhydrone electrode.
- 5) Titration of Fe<sup>+2</sup>Vs K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> – potentiometry
- 6) Verification of Beer-Lambert's law by Iron- thiocyanate system –colorimetry.
- 7) Determination of single electrode potential of Cu<sup>2+</sup>/Cu and estimate the given unknown concentration.

## VIII. Suggested Co- Curricular Activities

**Mandatory:** (Lab/field training of students by teacher: (lab:10+field:05):

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of handling the pHmetry, potentiometry and colorimetry. .
2. **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the synthetic reactions. Write their observations and submit a hand written field work /project work report not exceeding 10 pages in the given format to the teacher.
3. Max marks for Field work/project work Report: 05.
4. Suggested Format for Fieldwork/project work: Title page, student details, index page, details of place visited, observations, findings and acknowledgements.
5. Unit tests (IE).

## IX. Reference books:

1. Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J. D. Barnes and M. J. Thomas, 4<sup>th</sup> & 6<sup>th</sup> Ed. (Pearson Education Asia).

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## **Course 22B: Analytical Methods of Analysis**

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

**By the end of this course, students will be able to:**

1. Perform experiment with accuracy and precision.
2. Develop methods of analysis for different samples independently.
3. Test contaminated water samples.
4. Understand basic principle of instrument like Flame Photometer, UV-vis spectrophotometer.
5. Learn separation of analytes by chromatography.
6. Apply knowledge of geometrical isomers and keto-enol tautomers to analysis.
7. Determine composition of soil.
8. Estimate macronutrients using Flame photometry.

### **II. Syllabus:**

**Total: 45hours(3hr/Week)**

**Unit 1:Qualitative and quantitative aspects of analysis:9h**

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression.Normal law of distribution of indeterminate errors, statistical test of data; F, Q and t test, rejection of data,and confidence intervals.

**Unit 2:Optical methods of analysis**

**9 h**

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selectionRules.

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator anddetector) for single and double beam instrument; Transmittance.

Absorbance and Beer-Lambert lawBasic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometricalisomers, keto-enoltautomers.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice ofsource, monochromator, detector, choice of flame and Burner designs). Techniques of atomization andsample introduction; Method of background correction, sources of chemical interferences and theirmethod of removal, Techniques for the quantitative estimation of trace level of metal ions from watersamples.

**Unit 3:Thermal methods of analysis: 9 h**

Theory of thermogravimetry (TG) and basic principle of instrumentation of thermal analyser.Techniquesfor quantitative estimation of Ca and Mg from their mixture.

**Unit 4:Electroanalyticalmethods 9 h**

Classification of electro-analytical methods, basic principle of pH metric, potentiometric andconductometrictitrations.Techniques used for the determination of equivalence points.

Techniques usedfor the determination of pKa values.

**Unit5:Separation techniques9 h**

Solvent extraction: Classification, principle and efficiency of the technique.Mechanism of extraction: extraction by salvation and chelation, Technique of extraction: batch,continuous and counter current extractions, Qualitative and quantitative aspects of solvent extraction:extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueousmedia.

Chromatography: Classification, principle and efficiency of the technique, Mechanism of separation:adsorption, partition & ion-exchange.

**III. Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.

3. Visits of abilities, firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

#### IV. Suggested Text Books:

1. Willard, H.H.(1988),**Instrumental Methods of Analysis**, 7th Edition, Wardsworth Publishing Company.
2. Christian, G.D.(2004),**Analytical Chemistry**, 6th Edition, John Wiley & Sons, New York.
3. Harris, D. C.(2007),**Quantitative Chemical Analysis**,6th Edition, Freeman. V.

#### References:

1. Khopkar, S.M. (2008), **Basic Concepts of Analytical Chemistry**, New Age International Publisher.
2. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005), **Principles of Instrumental Analysis**, Thomson Asia Pvt. Ltd.

**Course 22B:** [Analytical Methods of Analysis- Practical Syllabus](#)Total:  
30hours(2hr/Week)

#### VI. Learning Outcomes

**By the end of the course students will be able to**

1. Separate ions using chromatography
2. Identify the ion by comparing Rf values with the literature
3. Analyze soil parameters
4. Verify Beer Lamberts law
5. Determine the carbonate and bicarbonate using pH

#### VII. Practical Syllabus

1. Separation of mixtures by paper chromatography and reporting the Rf values of  $\text{Co}^{2+}$  and  $\text{Ni}^{2+}$ .
2. Separation of mixtures by paper chromatography and reporting the Rf values of Amino acids present in the given mixture
3. To separate a mixture of  $\text{Ni}^{2+}$  &  $\text{Fe}^{2+}$  by complexation with DMG and extracting the  $\text{Ni}^{2+}$  DMG complex in chloroform, and determine its concentration by spectrophotometry
4. Analysis of soil:
  - (i) Determination of  $\text{p}^{\text{H}}$  of soil.
  - (ii) Estimation of calcium and magnesium
  - (iii) Qualitative detection of nitrate and phosphate

5. Verification of Lambert-Beer's law and determination of concentration of a coloured species ( $\text{CuSO}_4$ ,  $\text{KMnO}_4$ )
6. Determination of carbonate- and bicarbonate in a mixture using  $\text{p}^{\text{H}}$ metry

#### **VIII. Co-Curricular Activities:**

**Mandatory:***(Lab/field training of students by teacher :(lab:10+field:05):*

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of estimating the quality of soil.
2. **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes various measured parameters of soil analysis. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
3. Max. Marks for Fieldwork/project work Report:05.
4. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
5. Unittests(IE).

#### **IX. References:**

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C.(1989),**Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Analytical Chemistry by Gary D. Christian 6th Edition John Wiley & Sons Inc New York 1994.

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**Course 23A:** [Pharmaceutical and Medicinal Chemistry](#)

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

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

- 1) Know the Terminology in Pharmaceutical chemistry.
- 2) Describe the classification of Pharmaceutical chemistry
- 3) Learn the procedure for Synthesis and therapeutic activity of the compounds.
- 4) Acquire knowledge on Pharmacodynamics and Anesthetics Drugs
- 5) Gain knowledge on HIV-AIDS and Drugs.

#### **II. Syllabus:**

**Total theory: 45**

**hours(3h/week)**

**UNIT-I Pharmaceutical chemistry****9 hours**

**Terminology:** Pharmacy, Pharmacology, Pharmacophore, Pharmacodynamics, Pharmacokinetics (ADME, Receptors - brief treatment), Metabolites and Anti metabolites. Nomenclature: Chemical name, Generic name and trade names with examples.

**UNIT-II Classification of Drugs****9 hours**

Classification based on structures and therapeutic activity with one example each, Administration of drugs. Absorption of drugs - factors affecting absorption of drugs, routes of administration - local, enema, oral and external, parental routes - advantages and disadvantages.

**UNIT-III Synthesis and therapeutic activity of the compounds:****9hours**

a. Chemotherapeutic Drugs : 1. Sulpha drugs (Sulpha methoxazole) 2. Antibiotics -  $\beta$ Lactam Antibiotics, Macrolide Antibiotics, 3. Anti malarial Drugs (chloroquine)

b. Psychotherapeutic Drugs: 1. Anti pyretics (Paracetamol) 2. Hypnotics, 3. Tranquilizers (Diazepam) 4. Levodopa

**UNIT-IV Pharmacodynamics and Anesthetics Drugs:****9hours**

- 1) Antiasthma Drugs (Salbutamol)
- 2) Antianginals (Glyceryl trinitrate)
- 3) Diuretics (Furosemide)
- 4) Anesthetics - general - ether, chloroform, ethyl chloride, halothane, nitrous oxide, local - esters - cocaine, benzococaine.

**UNIT-V HIV-AIDS:****9 hours**

Immunity - CD-4cells, CD-8cells, Retro virus, Replication in human body, Investigation available, prevention of AIDS, Drugs available - examples with structures: PIS: Indinavir (crixivan), Nelfinavir (Viracept), AZT- Zidovudine.

**III. Suggested Co-Curricular Activities:**

- 1) Training of students by related industrial experts.
- 2) Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
- 3) Visits of related Industries/firms, research organizations etc.
- 4) Invited lectures and presentations on related topics by field/industrial experts.

**IV. List of text Books:**

- 1) Synthetic Drugs by O.D. Tyagi & M. Yadav
- 2) Medicinal Chemistry by P. Parimoo
- 3) Pharmacology & Pharmacotherapeutics R. S. Satoshkar & S. D. Bhandenkar
- 4) Reference Books:
- 5) Medicinal Chemistry by Dr. B. V. Ramana

- 6) Synthetic Drugs by O.D.Tyagi& M.Yadav
- 3) Medicinal Chemistry by Ashutoshkar
- 7) Medicinal Chemistry by P.Parimoo
- 8) Pharmacology& Pharmacotherapeutics R.SSatoshkar&S.D.Bhandenkar
- 9) Medicinal Chemistry by Kadamet P-I & P.II
- 10) European Pharmacopoeia.

**Course 17A. [Pharmaceutical and Medicinal Chemistry- Practical Syllabus](#)**

**V. Learning Outcomes:**

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

- 1) Learn the procedure for the synthesis of drugs.
- 2) Synthesis of Drugs Assisted by Microwave Oven
- 3) Acquire skills in Drawing structure and Reaction using Chemdraw
- 4) Know the reactions and mechanisms involved in synthesis of Drugs.

**VI. Laboratory course Syllabus** Total hours: 30h(2h/week)

- 1) Synthesis of Sulphanilamide
- 2) Synthesis of 7- Hydroxy -4- methyl coumarin
- 3) Synthesis of Chlorobutanol
- 4) Synthesis of Tolbutamide
- 5) Assay of Chlorpheniramine Maleate
- 6) Assay of Benzyl Penicillin
- 7) Synthesis of Aspirin Assisted by Microwave Oven
- 8) Drawing structure and Reaction using Chemdraw

**VII. List of Reference books:**

- 1) Wilson and Giswold's Organic medicinal and Pharmaceutical Chemistry.
- 2) Foye's Principles of Medicinal Chemistry.
- 3) Burger's Medicinal Chemistry, Vol I to IV.
- 4) Introduction to principles of drug design- Smith and Williams.
- 5) Remington's Pharmaceutical Sciences.
- 6) Martindale's extra pharmacopoeia.
- 7) Organic Chemistry by I.L. Finar, Vol. II.
- 8) The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
- 9) Text book of practical organic chemistry- A.I.Vogel.

**VIII.Suggested Co-Curricular Activities**

**Mandatory:**(Lab /field training of students by teacher:(lab: 10+field:05):

- 1) **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of comprehensive product development programs to meet new product criteria and timing. Acquire skills in the preparation of drugs and pharmaceuticals, learn the procedure of synthesis of drugs with good yield.
- 2) **For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observes the preparation of

- Cosmeceuticals and Pharmaceutical. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
- 3) Max marks for Fieldwork/project work Report: 05.
  - 4) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings, and acknowledgements.*
  - 5) Unit tests (IE).

#### **IX. Reference books:**

- 1) The Organic Chemistry of Drug Synthesis by Lednicer, Vol. 1-5.
- 2) Text book of practical organic chemistry- A.I. Vogel.

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#### **Course-23B.**

#### **Pesticides and Green Chemistry I. Learning Outcomes:**

On completion of this course, the student will be able to

1. Understand the basic knowledge of pesticides and their classification.
2. Explain the synthetic methods of pesticides.
3. Acquire knowledge about the different types of pesticide formulations and their use.
4. Explain concepts in green chemistry.
5. State and explain the principles of green chemistry.
6. Identify the need of green chemistry and green synthesis.
7. Think to design and develop materials and processes that reduce the use and generation of hazardous substances in industry.

#### **II. Syllabus: (Total Hours: 75 including Teaching, Lab, Field Skills Training, Unit tests etc.)**

**Total theory hours: 45h (3h/week)**

#### **Unit-I**

**Pesticides**

**9h**

Introduction to pesticides, advantages and disadvantages of pesticides, types of pesticides–Insecticides, Fungicides, Herbicides, Weedicides, Rodenticides plant growth regulators, Pheromones and Hormones. Brief discussion with examples, Structure and uses.

## **Unit-II**

### **Pesticides Synthesis**

**9h**

Synthesis and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil); Anilides (Alachlor and Butachlor).

## **Unit-III**

### **Pesticide Formulations**

**9h**

Dust and Granules, Wettable powders, seed disinfectant, Surfactants, Emulsifiable concentrates, Aerosols, Sprays, and Controlled Release Formulations.

## **Unit-IV**

**9h**

### **Green Chemistry**

Introduction: Definition of green Chemistry, need of green chemistry, twelve principles of Green Chemistry with their explanations and examples; Green Synthesis-Maximum utilization of reactants and reagents (atom economy). Selection

of solvent: Aqueous phase reactions, Reactions in ionic liquids, Solid supported synthesis, Solvent free reactions (solid phase reactions), and Green catalysts: Phase transfer catalysts (PTC) and Biocatalysts.

## **Unit-V**

**9h**

### **Green Synthesis**

Green Synthesis of the following compounds: Styrene, Adipic Acid, Catechol, BHT, Methyl Methacrylate, Urethane, 4-amino diphenyl amine, benzyl bromide, Acetaldehyde, Furfural, Ibuprofen, Paracetamol, Citral.

## **III. Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of related Industries/firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

## **IV. TEXT BOOKS**

1. Industrial chemistry by B.K. Sharma. Goel Publishing House, Meerut.
2. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.

3. Chemistry of pesticides by N.K. Roy
4. R. Cremling: Pesticides, John Wiley.
5. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
6. P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
7. A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).

#### **V. References Books:**

1. Fundamentals of industrial chemistry—pharmaceuticals, polymers and business by John A. Tyrell.
2. Riegel's Hand book of Industrial Chemistry ninth edition Edited by James A. Kent.
3. E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
4. Chemistry of pesticides by N.K. Roy
5. R. Cremling: Pesticides, John Wiley.
6. Pesticides Formulations—Van Wade. Velkenburg, 1973.
7. Pesticides Synthesis—Mavy, Kohn, Menn, 1979.
8. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).

### **Course-23B: Pesticides and Green Chemistry- Practical Syllabus:**

#### **VI. Laboratory-Skills Outcomes:**

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

1. List out, identify and handle various equipment in the laboratory.
2. Learn the procedures of green synthesis.
3. Acquire skills in Microwave assisted organic synthesis.
4. Perform some applications of green synthesis.

#### **VI. Practical (Laboratory) Syllabus**

**30h (2h/week)**

The list of suggestive experiments is given below. However, depending upon available resources, any three experiments may be conducted)

1. Benzoin condensation using Thiamine Hydrochloride as a catalyst (instead of cyanide).
2. Formation of Chalcones—A Greener Alternative.
3. Preparation of Salicylic Acid (Aspirin) by Microwave Assisted Method.
4. Green Synthetic Process for Acetanilide.
5. Green Synthetic Process for Dibenzal Propanone.
6. Green Synthetic Process for trans esterification of vegetable oil to crude bio-diesel.

#### **VII. Recommended Books / References:**

1. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. and Chaudhari, M.K.I.K. Green Chemistry Experiment: A monograph, International Publishing ISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. and Connelly, M.E. Real world cases in Green Chemistry, American Chemical Society (2008). UGC DOCUMENT ON LOFCHEMISTRY 83
6. Cann, M.C. and Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
7. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, Second Edition, 2010.
8. Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach, W. B. Saunders, 1995.

#### IX. Co-Curricular Activities

a. **Mandatory:** (Lab/field training of students by teacher: (lab:10+field:05):

1. **For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of comprehensive product development programs to meet new product criteria and timing. Acquire skills in the preparation of Cosmeceuticals and Pharmaceutical drugs, Carry out perfume testing with the knowledge of perfumes and learn the procedure of synthesis of drugs.
2. **For Students:** Students shall visit related industry/chemistry laboratory in universities/research organizations/private sector facility and observe the preparation of Cosmeceuticals and Pharmaceutical. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
  - a) Max marks for Field work/project work Report: 05.
  - b) Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
  - c) Unit tests (IE).

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**Course-24A: Corrosion and Its Prevention**

**I. Learning Outcomes:**

1. This course will create awareness of corrosion and its control process
2. It focuses on protective metallic coatings for prevention of corrosion
3. It focuses on protective coatings of materials.
4. It covers about the insulating materials in electric industries and also aware about semiconductors.

**II. Syllabus:**

**Total theory hours: 45h (3h/week)**

**Unit-I: Corrosion 9h**

Introduction - Economic aspects of corrosion - Dry or Chemical Corrosion - Wet or electrochemical corrosion - Mechanism of Electrochemical Corrosion. Galvanic Corrosion - Concentration Cell Corrosion - Differential aeration corrosion – Pitting Corrosion Underground or soil corrosion - Passivity.

**Unit-II: Corrosion and Its Control**

**9h**

Factors Influencing Corrosion - Microbiological Corrosion, Atmospheric corrosion – Corrosion Control - Proper designing – Using pure metal - Using metal alloys.

Chemical conversion – Coating - Phosphating - Chromising - Treatment of metal surfaces hot dipping - Use of inhibitors.

**Unit-III: Protective Coatings**

**9h**

Introduction - Metallic Coatings - Various methods of cleaning articles before electrodeposition – Electroplate and -Electroplating methods.

Pre-treatment of the surface – Metallic Coatings - Hot Dipping - Cementation or Impregnated Coatings - Sprayed Metal Coatings - Cladding – Vapour Deposition.

**Unit-IV Paints**

**9h Paints-**

ingredients and their functions, required properties of a Paint - Paint Constituents and their Functions - Manufacture of Paint.

Types of Pigments - Characteristics of pigment - Oils - Uses in Paint Emulsion Paints – Special Paints - Paint Remover Varnishes.

## **Unit-V: Insulators and Semiconductor 9h**

Electrical Insulating Materials-Dielectric properties-Requirements of an Electrical Insulating Material-Classification of insulating material-Electrical Rigid Insulations.

Semiconductors-Introduction-Classification–Degenerate semiconductors–Superconductors.

### **III. Suggested Co-Curricular Activities**

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of related Industries/firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

### **IV. Text Books**

1. M.G.Fontana:Corrosion Engineering, McGrawHillInternationalBookCo. London.
2. L.L. Shreir: Corrosion, Vol I and Vol II, Newness Butterworths, EdwardArnoldLtd, London.
3. J.C.Scully:Fundamental of Corrosion,PergamonPressInc.NewYork, USA.

### **V. References Books:**

1. M.G.Fontana:CorrosionEngineering,McGraw Hill InternationalBookCo. London.
2. L.L. Shreir: Corrosion, Vol I and Vol II, Newness Butterworths, EdwardArnoldLtd, London.
3. J.C.Scully:Fundamental of Corrosion,PergamonPressInc.NewYork, USA.
4. V.S.Sastry:CorrosionInhibitors,Principles&Applications,JohnWiley&Sons.
5. C.C.Nathan:CorrosionInhibitors,NACE,Houston,Texas.
6. Corrosion-Causes and Prevention:Speller.F. N.
7. Material Science mini refresher byH.S.Bawa, TatapublisherIndia.

### **Course 24A: Corrosion and its Prevention-Practical Syllabus:**

### **VI. Learning Outcomes:**

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

1. Chalk out a plan to decrease the rate of corrosion.
2. Preparation of pigment.
3. To study about the Rate of corrosion with respect to Aluminium and Iron plates
4. To determine the effect of Temperature on rate of corrosion

### **VII. Practical(Laboratory)Syllabus:**

**Total Hours: 30h(2h/week)**

1. Electroless metallic coatings on ceramic and plastic material.
2. Preparation of pigment (zinc oxide)
3. To determine the rate of corrosion on different metallic plates (Iron, Aluminium) in various concentrations of HCl.
4. To determine the effect of temperature on rate of corrosion in acidic medium.
5. To determine the rate of corrosion on a metallic plate in acidic medium.
6. To determine the rate of corrosion on an Aluminium plate in basic medium.

### **VIII. Lab References:**

1. Analytical Chemistry by Gary D. Christian 6th edition Wiley publication.
2. Senior Practical Physical Chemistry, B.D. Khosla, V.C. Garg, Adarsh Gulati, R Chand and Co.
3. Applied Chemistry Theory and Practice, O.P. Virani, A.K. Nebula. New Age International Publishers, 2nd Edition.
4. S.W. Rajbhoj and T.K. Chondhekar, Systematic Experimental Physical Chemistry, Anjali Publication, Second Edition 2000.
5. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons, Second Edition, 2008
6. Khosla, B.D.; Garg, V.C. & Gulati, A. Senior Practical Physical Chemistry, R.C. hand & Co.: New Delhi (2011).
7. UGC practical manual for experimental analysis.

### **IX. Cocurricular Activities:**

**a) Mandatory:** (Lab/field training of students by teacher: (lab:10+fields:05):

**1. For Teacher:** Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of corrosion formation observations in nature.

**2. For Students:** Student shall visit a related industry/chemistry laboratory in universities/research organizations/private sector facility and observe corrosion process and its prevention. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher. And also observe the semiconductors, insulators used in industry.

**a.** Max marks for Fieldwork/project work Report: 05.

**b.** Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

**c.** Unit tests (IE).

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**Course 24B: Material & Energy Balances and Utilities in Chemical Industry**

**I. Learning Outcomes:**

At the end of the course student will be able to

1. Describe the distinction between Atomic weight, Molecular weight and Equivalent Weight.
2. Write down the flow diagrams for chemical engineering operations. CO3
3. Describe the capacities of gases and gaseous mixtures.
4. Write down water treatment procedures for industrial use.
5. Describe the types of boilers.

6. Demonstrate knowledge acquired in steam generation.
7. Write down compressors and blowers.
8. Classify pumps based on their function.

## II. Syllabus: (Total Hours: 75 including Teaching, Lab, Field Skills Training, Unit test setc.)

**Total hours: 45h (3h/week)**

### Unit-I

**9h**

**Dimensions and units:** Basic Chemical Calculations - Atomic weight, molecular weight, equivalent weight, Mole, composition of (i) Liquid mixtures and (ii) gaseous mixtures. Ideal gas law, vapor pressure, Humidity and Saturation.

### Unit-II

**9h**

**Material Balance without Chemical Reactions:** Flow diagram for material balance, simple material balance with or without recycle or by-pass for chemical engineering operations such as distillation, absorption, crystallization, evaporation and extraction.

**Material Balance involving chemical reactions:** concept of limiting reactant, conversion, yield, selectivity and liquid phase reaction, gas phase reaction with or without recycle or by pass.

### Unit-III

**9h**

**Energy Balance:** Heat capacity of pure gases and gaseous mixtures at constant pressures, sensible heat changes in liquids, Enthalpy changes during phase transformation: Enthalpy of fusion, Enthalpy of vaporization,

Enthalpy of condensation, Enthalpy of sublimation, Hess's law of constant, Heat Summation and its applications

### Unit-IV 9h

#### Utilities in Chemical Industry

- a) **Boilers:** Types of boilers and their functioning
- b) **Water:** Specifications of industrial use, various water treatments.
- c) **Steam:** Generation and use.
- d) **Air:** Specification of industrial use, processing of air

### Unit-V

**9h**

#### Fluid flow and Pumps

**Fluid flow:** Fans, blowers, compressors, vacuum pump, ejectors.

**Pumps:** Reciprocating pumps, Gear pumps, centrifugal pumps.

### III. Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments, Seminars and Quiz (on related topics), collection of relevant videos and material.
3. Visits of related Industries/firms, research organizations etc.
4. Invited lectures and presentations on related topics by field/industrial experts.

### IV. Text Books:

1. E.Stocchi:*Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
3. P.C.Jain, M.Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
4. B.K.Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

### V. Reference Books:

1. B.I. Bhatt and S.M. Vora: *Stoichiometry*, Tata McGraw-Hill publishing Company Ltd, New Delhi.
2. E.Stocchi:*Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK
3. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
4. J.A.Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
5. P.C.Jain, M.Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
6. R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
7. B.K.Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut
8. S.C.Bhatia: *Chemical Process Industries*, Vol.I&II, CBS Publishers, New Delhi.
9. W. L. McCabe and J. C. Smith: *Unit Operations in Chemical Engineering*, Mc-Graw Hill Book Company, New York.
10. O. P. Vermani, A. K. Narula: *Industrial Chemistry*, Galgotia Publications Pvt. Ltd., New Delhi.

### Course 24B: Material & Energy Balances and Utilities in Chemical Industry-Practical Syllabus

#### VI. Learning Outcomes

At the end of the course student will be able to

1. Carry out the Quantitative analysis of calcium in lime stone.
2. Determine the hardness of given water sample using EDTA.
3. Determine COD and BOD of a given water sample.
4. Find out the Percentage of available chlorine present in the bleaching powder.

#### VII. Practical Syllabus Total hours: 30h (2h/week)

1. Quantitative analysis of calcium in limestone by complexometric titration.
2. Hardness of water by EDTA titration.
3. Determination of Chemical Oxygen Demand (COD)
4. Determination of Biological Oxygen Demand (BOD)

5. Percentage of available chlorine in bleaching powder

#### VIII. Reference Books:

1. 4.J.A.Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
2. 5.P.C.Jain, M.Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. 6.R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
4. 7.B.K.Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut
5. 8.S.C.Bhatia: *Chemical Process Industries*, Vol. I & II, CBS Publishers, New Delhi.

#### IX. Co-Curricular Activities:

##### a). Mandatory:

1. For Teacher: Training of students by the teacher in laboratory and field for not less than 15 hours on the field techniques/skills of detection of N, S and halogens using the green procedure, preparation of TLC plates, detection of organic compounds using  $R_f$  values in TLC/paper chromatography, loading of column, selection of solvents system for column chromatography, separation of amino acids and dye mixture using chromatographic techniques.
2. **For Students:** Student shall visit a related industry/ chemistry laboratory in universities/research organizations/private sector facility and observe the synthetic reactions. Write their observations and submit a hand written fieldwork/project work report not exceeding 10 pages in the given format to the teacher.
  - a. Max marks for Field work/project work Report: 05.
  - b. Suggested Format for Fieldwork/project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
  - c. Unit tests (IE).

**SUBJECT EXPERTS:**

1. Dr. K. RayappaReddy, Andhra Loyola college, Vijayawada.
2. Dr. CA Jyothirmayee,  
Ch SD St Theresa's college for women,  
Eluru.
3. Dr. Gopi Mamidi,  
Dr V.S. Krishna Govt. Degree College, Visakhapatnam.

**4. SYLLABUS VETTED BY:**

Prof. C. Suresh Reddy,

Professor Department of Chemistry S.V.  
University Tirupati.