



## **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 2020-21**

#### **PROGRAMME: FOUR-YEAR UG HONOURS PROGRAMME**

CHEMISTRY

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

*For Fifteen Courses of 1, 2, 3 & 4 Semesters)*

**(To be Implemented from 2020-21 Academic Year)**

**Andhra Pradesh State Council of Higher Education**

## B.Sc. Chemistry Revised Syllabus under CBCS

w.e.f. 2020-21

### Structure of Chemistry Core Syllabus under CBCS

YEAR	SEMESTER	COURSE	TITLE	MARKS	CREDITS
<b>I</b>	<b>I</b>	<b>I</b>	Inorganic and Physical Chemistry	100	03
			Practical – I Analysis of SALT MIXTURE	50	02
	<b>II</b>	<b>II</b>	Organic and General Chemistry	100	03
			Practical – II Volumetric Analysis	50	02
<b>II</b>	<b>III</b>	<b>III</b>	Organic Chemistry and Spectroscopy	100	03
			Practical – III Organic preparations and IR Spectral Analysis	50	02
	<b>IV</b>	<b>IV</b>	Inorganic, Organic and Physical Chemistry	100	03
			Practical – IV Organic Qualitative analysis	50	02
		<b>V</b>	Inorganic and Physical Chemistry	100	02
			Practical-V Course Conductometric and Potentiometric Titrimetry	50	02

## SEMESTER – I

**Course I (Inorganic & Physical Chemistry)**

**60 hrs. (4h/w)**

### **Course outcomes:**

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

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

### **INORGANIC CHEMISTRY**

**24 h**

#### **UNIT –I**

#### **Chemistry of p-block elements**

**8h**

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

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

**Group 15:** Preparation & structures of Phosphonitrilic halides  $\{(PNCl_2)_n\}$  where  $n=3, 4$

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

**Group 17:** Pseudohalogens, Structures of Interhalogen compounds.

#### **UNIT-II**

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

**6h**

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

#### **2. Chemistry of f-block elements:**

**6h**

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

#### **3. Theories of bonding in metals:**

**4h**

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

## **PHYSICAL CHEMISTRY**

**36h**

### **UNIT-III**

#### **Solid state**

**10h**

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

### **UNIT-IV**

#### **1. Gaseous state**

**6h**

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

#### **2. Liquid state**

**4h**

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

### **UNIT-V**

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

#### **1. Solutions**

**6h**

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

#### **2. Ionic equilibrium**

**3h**

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

#### **3. Dilute solutions**

**7h**

Colligative properties- RLVP, Osmotic pressure, Elevation in boiling point and depression in freezing point. Experimental methods for the determination of molar mass of a non-volatile

solute using osmotic pressure, Elevation in boiling point and depression in freezing point.  
Abnormal colligative properties. Van't Hoff factor.

### **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: Enhance critical thinking skills and personality
4. Semester-end Examination: critical indicator of student's learning and teaching methods adopted by teacher throughout the semester.

### **List of Reference Books**

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

## LABORATORY COURSE -I

30hrs (2 h / w)

### Practical-I Analysis of SALT MIXTURE

(At the end of Semester-I)

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

**50 M**

#### Course outcomes:

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

1. Understand the basic concepts of qualitative analysis of inorganic mixture
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

#### Analysis of SALT MIXTURE

**50 M**

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

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

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

## MODEL PAPER

FIRST YEAR B.Sc., DEGREE EXAMINATION

### SEMESTER-I

### CHEMISTRY Course-I: INORGANIC & PHYSICAL CHEMISTRY

Time: 3 hours

Maximum Marks: 75

**PART- A5 X 5 = 25 Marks**

Answer any **FIVE** of the following questions. Each carries **FIVE** marks

1. Explain the preparation & structures of Phosphonitrilic compounds.
2. Explain in brief, catalytic properties & stability of various oxidation states of d-block elements.
3. Write short note on Bravais lattices and crystal systems.
4. What are Smectic & Nematic liquid Crystals? Explain.

5. Write account on Common ion effect & Solubility product.
6. Describe Andrew's isotherms of carbon dioxide.
7. Explain Actinide Contraction.
8. Explain the structure of Borazine.

**PART- B5 X 10 = 50 Marks**

Answer **ALL** the questions. Each carries **TEN** marks

- 9 (a). Explain Classification, Preparations & uses of Silicones

(or)

- (b). (i) What are Pseudohalogens.  
(ii) Explain the Structures of any one AX<sub>3</sub>& AX<sub>5</sub> interhalogen compounds.

- 10 (a). What is Lanthanide Contraction? Explain the Consequences of Lanthanide Contraction.

(or)

- (b). (i) Explain the magnetic properties of d- block elements.  
(ii) Explain about Conductors, Semi-Conductors & Insulators using Band Theory.

- 11.(a). Write an essay on Crystal defects.

(or)

- (b). What is Bragg's Law. Explain the determination of structure of a crystal by powder method.

- 12.(a). Derive the relationship between Critical constants & Vanderwaal constants

(or)

- (b).(i) Write any 5 differences between liquid crystals & liquids, solids  
(ii) Write the applications of Liquid crystals.

- 13.(a). Explain Nernst distribution Law. Explain its applications

(or)

- (b).What are colligative properties. Write experimental methods for determination of molar mass of a non-volatile solute by using Elevation in boiling point & depression in freezing point.

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## **SEMESTER – II**

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

#### **Course outcomes:**

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

1. Understand and explain the differential behavior 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 including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution.
4. Correlate and describe the stereochemical properties of organic compounds and reactions.

#### **ORGANIC CHEMISTRY**

**36h**

##### **UNIT-I**

##### **Recapitulation of Basics of Organic Chemistry**

##### **Carbon-Carbon sigma bonds (Alkanes and Cycloalkanes)**

**12h**

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

##### **UNIT-II**

##### **Carbon-Carbon pi Bonds (Alkenes and Alkynes)**

**12h**

General methods of preparation, physical and chemical properties. Mechanism of E1, E2, E1cB reactions, Saytzeff and Hoffmann eliminations, Electrophilic Additions, mechanism (Markownikoff/Antimarkownikoff addition) with suitable examples, *syn* and *anti*-addition; addition of H<sub>2</sub>, X<sub>2</sub>, HX. oxymercuration-

demercuration, hydroboration-oxidation, ozonolysis, hydroxylation, Diels Alder reaction, 1,2- and 1,4-addition reactions in conjugated dienes.

Reactions of alkynes; acidity, electrophilic and nucleophilic additions, hydration to form carbonyl compounds, Alkylation of terminal alkynes.

### **UNIT-III**

#### **Benzene and its reactivity**

**12h**

Concept of aromaticity, Huckel's rule - application to Benzenoid (Benzene, Naphthalene) and Non - Benzenoid compounds (cyclopropenyl cation, cyclopentadienyl anion and tropylium cation)

Reactions - General mechanism of electrophilic aromatic substitution, mechanism of nitration, Friedel-Craft's alkylation and acylation. Orientation of aromatic substitution - ortho, para and meta directing groups. Ring activating and deactivating groups with examples (Electronic interpretation of various groups like  $\text{NO}_2$  and Phenolic). Orientation of (i) Amino, methoxy and methyl groups (ii) Carboxy, nitro, nitrile, carbonyl and sulphonic acid groups (iii) Halogens

(Explanation by taking minimum of one example from each type)

### **GENERAL CHEMISTRY**

**24 h**

#### **UNIT-IV**

#### **1. Surface chemistry and chemical bonding**

##### **Surface chemistry**

**6h**

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

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

##### **2. Chemical Bonding**

**6h**

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

### 3. HSAB

2h

Pearson's concept, HSAB principle & its importance, bonding in Hard-Hard and Soft-Soft combinations.

### UNIT-V

#### Stereochemistry of carbon compounds

10h

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

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

D,L, R,S and E,Z- configuration with examples.

Definition of Racemic mixture – Resolution of racemic mixtures (any 3 techniques)

#### Co-curricular activities and Assessment Methods

Continuous Evaluation: Monitoring the progress of student's learning

Class Tests, Worksheets and Quizzes

Presentations, Projects and Assignments and Group Discussions: Enhance critical thinking skills and personality

Semester-end Examination: critical indicator of student's learning and teaching methods adopted by teacher throughout the semester.

#### List of Reference Books

##### Theory:

Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.

Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

##### Practical:

Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

**Additional Resources:**

Solomons, T. W. G.; Fryhle, C. B. & Snyder, S. A. Organic Chemistry, 12th Edition, Wiley.

Bruice, P. Y. Organic Chemistry, Eighth Edition, Pearson.

Clayden, J.; Greeves, N. & Warren, S. Organic Chemistry, Oxford.

Nasipuri, D. Stereochemistry of Organic Compounds: Principles and Applications, Third Edition, NewAge International.

Gunstone, F. D. Guidebook to Stereochemistry, Prentice Hall Press, 1975.

**LABORATORY COURSE-II**

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

**Practical-II Volumetric Analysis**

(At the end of Semester-II)

**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. This may include: The concept of the mole; Converting moles to grams; Converting grams to moles; Defining concentration; Dilution of Solutions; Making different molar concentrations.

**Volumetric analysis**

**50 M**

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Determination of Fe (II) using  $\text{KMnO}_4$  with oxalic acid as primary standard.

- Determination of Cu (II) using  $\text{Na}_2\text{S}_2\text{O}_3$  with  $\text{K}_2\text{Cr}_2\text{O}_7$  as primary standard.
- Estimation of water of crystallization in Mohr's salt by titrating with  $\text{KMnO}_4$

**MODEL PAPER**  
**FIRST YEAR B.Sc., DEGREE EXAMINATION**  
**SEMESTER-II**  
**CHEMISTRY COURSE -II: ORGANIC & GENERAL CHEMISTRY**

Time: 3 hours

Maximum Marks: 75

**PART- A**

5 X 5 = 25 Marks

Answer any **FIVE** of the following questions. Each carries **FIVE** marks

- Write different conformations of n-butane. Explain their relative stability..
- Explain 1,2- & 1,4- addition reactions of conjugated dienes.
- Explain the orientation effect of halogens on mono substituted benzene.
- Explain the mechanism of  $\text{E1}^{\text{CB}}$  elimination reaction.
- Explain the structure of  $\text{ClF}_3$  by Valency Bond theory.
- What are Hard & soft acids & bases? Explain with examples.
- Draw the Wedge, Fischer, Newmann & saw-Horse representations for Tartaric acid.
- Define Enantiomers and Diastereomers and give two examples for each.

**PART- B**

5 X 10 = 50 Marks

Answer **ALL** the questions. Each carries **TEN** marks

- (a). (i) Write the preparation of alkanes by Wurtz and Corey-House reaction.  
(ii) Explain Halogenation of alkanes. Explain the reactivity and selectivity in free radical substitutions.  
(or)
  - (b). (i) Explain Baeyer Strain Theory  
(ii) Draw the conformations of Cyclohexane and explain their stability by drawing energy profile diagram.
- (a). (i) Write any two methods of preparation of alkenes.  
(ii) Explain the mechanism of Markownikoff and Anti-Markownikoff addition of  $\text{HBr}$  to alkene.  
(or)

- (b). (i) Explain the acidity of 1-alkynes  
(ii) How will you prepare acetaldehyde and acetone from alkynes?  
(iii) Write alkylation reaction of terminal alkene.
- 11.(a). Define Huckel rule of aromatic compounds. What are benzenoid and non-benzenoid aromatic compounds? Give examples.  
(or)
- (b). Explain the mechanisms of Nitration and Friedel-Craft's alkylation of Benzene.
- 12.(a). (i) Define Hardy-Schulze rule & Gold number.  
(ii) Differentiate Physisorption & Chemisorption. Explain Langmuir adsorption isotherm.  
(or)
- (b). Construct the Molecular Orbital diagram for O<sub>2</sub> and NO and explain their bond order and magnetic property.
- 13.(a). Define racemic mixture. Explain any two techniques for resolution of racemic mixture.  
(or)
- (b).(i) Define Optical activity and Specific rotation.  
(ii) Draw the R- & S- isomers of Alanine, Glyceraldehyde.  
(iii) Write the E- & Z- isomers of 2-butene.

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### SEMESTER - III

**Course III (ORGANIC CHEMISTRY & SPECTROSCOPY) 60hrs (4 h / w)**

#### Course outcomes:

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

1. Understand preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups.
2. Use the synthetic chemistry learnt in this course to do functional group transformations.
3. To propose plausible mechanisms for any relevant reaction

## ORGANIC CHEMISTRY

34h

### UNIT – I

#### 1. Chemistry of Halogenated Hydrocarbons:

6h

Alkylhalides: Methods of preparation and properties, nucleophilic substitution reactions –  $S_N1$ ,  $S_N2$  and  $S_Ni$  mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination, Williamson's synthesis.

Arylhalides: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution;  $S_NAr$ , Benzyne mechanism.

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

#### 2. Alcohols & Phenols

6h

Alcohols: preparation, properties and relative reactivity of  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  alcohols, Bouvaelt Blanc Reduction; Oxidation of diols by periodic acid and lead tetra acetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors affecting it, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

### UNIT-II

#### Carbonyl Compounds

10h

Structure, reactivity, preparation and properties;

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonium derivatives

Mechanisms of Aldol and Benzoin condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann haloform reaction and Baeyer-Villiger oxidation,  $\alpha$ -substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, with  $LiAlH_4$  &  $NaBH_4$ ).

Addition reactions of  $\alpha, \beta$ -unsaturated carbonyl compounds: Michael addition.

Active methylene compounds:

Keto-

enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

### UNIT-III

#### Carboxylic Acids and their Derivatives

12h

General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids.

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Reformatsky reactions and Curtius rearrangement

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

## **SPECTROSCOPY**

**26 h**

### **UNIT-IV**

#### **Molecular Spectroscopy:**

**18h**

Interaction of electromagnetic radiation with molecules and various types of spectra;

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

**Vibrational spectroscopy:** Classical equation of vibration, computation of force constant, Harmonic and anharmonic oscillator, Morse potential curve, vibrational degrees of freedom for polyatomic molecules, modes of vibration. Selection rules for vibrational transitions, Fundamental frequencies, overtones and hot bands.

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

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

**Application of Spectroscopy to Simple Organic Molecules****Application of visible, ultraviolet and Infrared spectroscopy in organic molecules.**

Application of electronic spectroscopy and Woodward rules for calculating  $\lambda_{\max}$  of conjugated dienes and  $\alpha,\beta$  – unsaturated compounds.

Infrared radiation and types of molecular vibrations, functional group and fingerprint region.

IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on  $>C=O$  stretching absorptions).

**Co-curricular activities and Assessment Methods** Continuous Evaluation: Monitoring the progress of student's learning Class Tests, Work sheets and Quizzes Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality Semester-end Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

**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
11. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
12. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012)

13. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

**LABORATORY COURSE -III**

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

**Practical Course-III Organic preparations and IR Spectral Analysis**

(At the end of Semester- III)

**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 engage in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately
4. how to dispose of chemicals in a safe and responsible manner
5. how to perform common laboratory techniques including reflux, distillation, recrystallization, vacuum filtration.
6. how to create and carry out work up and separation procedures
7. 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

**Organic preparations:**

**40M**

i. Acetylation of one of the following compounds:

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

- a. Using conventional method.
- b. Using green approach

ii. Benzoylation of one of the following amines

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

iii. Nitration of any one of the following:

- a. Acetanilide/nitrobenzene by conventional method
- b. Salicylic acid by green approach (using ceric ammonium nitrate).

**IR Spectral Analysis**

**10M**

IR Spectral Analysis of the following functional groups with examples

- a) Hydroxyl groups
- b) Carbonyl groups
- c) Amino groups
- d) Aromatic groups

**MODEL PAPER**  
**SECOND YEAR B.Sc., DEGREE EXAMINATION**  
**SEMESTER-III**  
**CHEMISTRY COURSE-III: ORGANIC CHEMISTRY &**  
**SPECTROSCOPY**

Time: 3 hours

Maximum Marks: 75

**PART- A**

5 X 5 = 25 Marks

Answer any **FIVE** of the following questions. Each carries **FIVE** marks

1. Discuss two methods for preparation of aryl halides.
2. Explain the mechanism for Pinacol-Pinacolone rearrangement.
3. Discuss the mechanism for Bayer-villiger oxidation reaction.
4. Explain the effect of substituents on acidic strength of mono-carboxylic acids.
5. Write the mechanism for Claisen Condensation reaction.
6. Write the selection rules in rotational spectroscopy.
7. Explain Spin – Spin coupling and Coupling Constant.
8. Explain types of electronic transitions in UV spectroscopy.

**PART- B**

5 X 10 = 50 Marks

Answer **ALL** the questions. Each carries **TEN** marks

- 9 (a). Give the mechanism & stereochemistry of  $SN^1$  &  $SN^2$  reactions of alkyl halides with suitable example.

(or)

- (b). Explain the following reactions with mechanism.  
(i) Reimer-Tiemann reaction (ii) Fries rearrangement.

- 10 (a). Discuss the mechanism for following reactions.  
(i) Perkin reaction. (ii) Cannizzaro reaction

(or)

(b). Write the preparation and any three synthetic applications of diethyl malonate.

11.(a). Explain acid and base hydrolysis reaction of esters with mechanism.

(or)

(b). Explain the mechanisms of Curtius rearrangement & Arndt –Eistert reaction.

12.(a). (i) Write a note on vibrational degrees of freedom for polyatomic molecules.

(ii) Explain different modes of vibrations & selection rules in IR spectroscopy.

(or)

(b).(i) Define Bathochromic shift. Explain the effect of conjugation in U.V. spectroscopy.

(ii) Discuss the principle of NMR spectroscopy.

13.(a). Write Woodward-Fieser rules for calculating  $\lambda_{\max}$  for conjugated dienes and  $\alpha,\beta$  – unsaturated carbonyl compounds, and apply them for one example each.

(or)

(b).(i) What is Fingerprint region. Explain its significance with an example.(ii)

Write IR spectral data for any one alcohol, aldehyde and ketone

## SEMESTER - IV

**Course IV (INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY) 60hrs (4 h / w)**

### Course outcomes:

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

1. To learn about the laws of absorption of light energy by molecules and the subsequent photochemical reactions.
2. To understand the concept of quantum efficiency and mechanisms of photochemical reactions.

### UNIT - I

**Organometallic Compounds**

**8h**

Definition and classification of organometallic Compounds on the basis of bond type, Concept of hapticity of organo ligands. Metalcarbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metalcarbonyls of 3d series. General methods of preparation of mono and binuclear carbonyls of 3d series.  $\pi$ -acceptor behaviour of carbon monoxide. Synergic effects (VB approach) - (MO diagram of CO can be referred to for synergic effect to IR frequencies).

## UNIT – II

### Carbohydrates

8h

Occurrence, classification and their biological importance, Monosaccharides: Constitution and absolute configuration 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 – Elementary treatment of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch.

## UNIT- III

### Amino acids and proteins

6h

Introduction: Definition of Amino acids, classification of Amino acids into alpha, beta, and gamma amino acids. Natural and essential amino acids - definition and examples, classification of alpha amino acids into acidic, basic and neutral amino acids with examples. Methods of synthesis: General methods of synthesis of alpha amino acids (specific examples - Glycine, Alanine, valine and leucine) by following methods: a) from halogenated carboxylic acid b) Gabriel Phthalimide synthesis c) strecker's synthesis.

Physical properties: Zwitter ion structure - salt like character - solubility, melting points, amphoteric character, definition of isoelectric point.

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

### Heterocyclic Compounds

7h

Introduction and definition: Simple five membered ring compounds with one hetero atom Ex. Furan. Thiophene and pyrrole - Aromatic character – Preparation from 1, 4, -dicarbonyl compounds, Paul-Knorr synthesis.

Properties: Acidic character of pyrrole - electrophilic substitution at 2 or 5 position, Halogenation, Nitration and Sulphonation under mild conditions - Diels Alder reaction in furan.

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

#### **UNIT- IV**

#### **Nitrogen Containing Functional Groups**

Preparation, properties and important reactions of nitrocompounds, amines and diazonium salts.

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

**3h**

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

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

**11h**

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

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

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

#### **UNIT- V**

##### **Photochemistry**

**5h**

Difference between thermal and photochemical processes, Laws of photochemistry- Grothuss-Draper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield- Photochemical reaction mechanism- hydrogen- chlorine and hydrogen- bromine reaction. Qualitative description of fluorescence, phosphorescence, Jablonski diagram, Photosensitized reactions- energy transfer processes (simple example).

## **Thermodynamics**

**12 h**

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

**Co-curricular activities and Assessment Methods** Continuous Evaluation : Monitoring the progress of student's learning Class Tests, Work sheets and Quizzes Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality Semester-end Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

### **List of Reference Books**

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

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

**Practical Course-IV Organic Qualitative analysis**

**50 M**

(At the end of Semester- 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

**Organic Qualitative analysis**

**50 M**

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

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

**MODEL PAPER**

**SECOND YEAR B.Sc., DEGREE EXAMINATION**

**SEMESTER-IV**

**CHEMISTRY COURSE -IV: INORGANIC, ORGANIC & PHYSICAL  
CHEMISTRY**

Time: 3 hours

Maximum Marks: 75

**PART- A**

5 X 5 = 25 Marks

Answer any **FIVE** of the following questions. Each carries **FIVE** marks

1. Describe the 18 electron rule of mono nuclear and polynuclear metal carbonyls with suitable examples.
2. What are epimers and anomers. Give examples.
3. Discuss about iso electric point and zwitter ion.
4. Discuss the Paul-Knorr synthesis of five membered heterocyclic compounds.

5. Explain Tautomerism shown by nitro alkanes
6. Discuss the basic nature of amines.
7. Write the differences between thermal and photochemical reactions.
8. Derive heat capacities and derive  $C_p - C_v = R$

**PART- B**

5 X 10 = 50 Marks

Answer **ALL** the questions. Each carries **TEN** marks

- 9 (a). What are organometallic compounds? Discuss their Classification on the basis of type of bonds with examples.  
(or)
- (b). Discuss the general methods of preparations of mono & bi-nuclear carbonyls of 3d series.
- 10 (a). Discuss the constitution, configuration and ring size of glucose. Draw the Haworth and Conformational structure of glucose.  
(or)
- (b). (i) Explain Ruff's degradation.  
(ii) Explain Kiliani- Fischer synthesis.
- 11.(a). What are amino acids? Write any three general methods of preparation of amino acids.  
(or)
- (b). Discuss the aromatic character of Furan, Thiophene and Pyrrole.
- 12.(a). Write the mechanism for the following.  
(i) Nef reaction                      (ii) Mannich reaction  
(or)
- (b).(i) Explain Hinsberg separation of amines.  
(ii) Discuss any three synthetic applications of diazonium salts.
- 13.(a). What is quantum yield? Explain the photochemical combination of Hydrogen-Chlorine and Hydrogen - Bromine.  
(or)
- (b). Define entropy. Describe entropy changes in the reversible and irreversible process.

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## SEMESTER - IV

Course V (INORGANIC & PHYSICAL CHEMISTRY) 60 hrs (4 h / w)

### Course outcomes:

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

1. Understand concepts  
Of boundary conditions and quantization, probability distribution, most probable values, uncertainty and expectation values
2. Application of quantization to spectroscopy.
3. Various types of spectra and the irusein structure determination.

### INORGANIC CHEMISTRY

26 h

#### UNIT –I

##### Coordination Chemistry

12 h

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

#### UNIT –II

##### 1. Inorganic Reaction Mechanism:

4h

Introduction to inorganic reaction mechanisms. Concept of reaction pathways, transition state, intermediate and activated complex. Labile and inert complexes, lig and substitution reactions -  $SN^1$  and  $SN^2$ , Substitution reactions in square planar complexes, Trans-effect, the ories of trans effect and its applications

##### 2. Stability of metal complexes:

2h

Thermodynamic stability and kinetic stability, factors affecting the stability of metal complexes, chelate effect, determination of composition of complex by Job's method and mole ratio method.

##### Bioinorganic Chemistry:

8h

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals, Sodium/K- pump, carbonic anhydrase and carboxypeptidase.

Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cisplatin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin, Myoglobin. Storage and transfer of iron.

## **PHYSICAL CHEMISTRY**

**34 h**

### **UNIT-III**

#### **1 .Phase rule**

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

### **UNIT-IV**

#### **Electrochemistry**

**14h**

Specific conductance, equivalent conductance and molar conductance- Definition and effect of dilution. Cell constant. Strong and weak electrolytes, Kohlrausch's law and its applications, Definition of transport number, determination of transport number by Hittorf's method. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only), Application of conductivity measurements- conductometric titrations.

Electrochemical Cells- Single electrode potential, Types of electrodes with examples: Metal-metal ion, Gas electrode, Inert electrode, Redox electrode, Metal-metal insoluble salt- salt anion. Determination of EMF of a cell, Nernst equation, Applications of EMF measurements - Potentiometric titrations.

Fuel cells- Basic concepts, examples and applications

### **UNIT-V**

#### **Chemical Kinetics:**

**14 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 (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Enzyme catalysis- Specificity,

factors affecting enzyme catalysis, Inhibitors and Lock & key model. Michaels- Menten equation- derivation, significance of Michaelis-Menten constant.

**Co-curricular activities and Assessment Methods** Continuous Evaluation: Monitoring the progress of student's learning Class Tests, Work sheets and Quizzes Presentations, Projects and Assignments and Group Discussions: Enhances critical thinking skills and personality Semester-end Examination: critical indicator of student's learning and teaching methods adopted by teachers throughout the semester.

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3. Advanced Inorganic Chemistry Vol-I by Satyaprakash, Tuli, Basu and Madan
4. Advanced physical chemistry by Gurudeep Raj
5. Principles of physical chemistry by Prutton and Marron
6. Advanced physical chemistry by Bahl and Tuli
7. Inorganic Chemistry by J.E.Huheey
8. Basic Inorganic Chemistry by Cotton and Wilkinson
9. A textbook of qualitative inorganic analysis by A.I. Vogel
10. Atkins,P.W.&Paula,J.deAtkin'sPhysicalChemistryEd.,OxfordUniversityPress  
10thEd(2014).
11. Castellan,G.W.PhysicalChemistry4thEd.Narosa(2004).
12. Mortimer,R. G.PhysicalChemistry3rdEd. Elsevier:NOIDA,UP(2009).
13. Barrow,G.M.PhysicalChemistry

## SEMESTER - IV

**Course V**                      **LABORATORY COURSE**                      **30hrs (2 h / w)**

**Practical-Course -V Conductometric and Potentiometric Titrimetry**                      **50 M**

### **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 electrochemistry in experiments
3. Be familiar with electro analytical methods and techniques in analytical chemistry which study an analyte by measuring the potential ( volts) and/or current ( amperes) in an electrochemical cell containing the analyte

**Conductometric and Potentiometric Titrimetry**                      **50 M**

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

**MODEL PAPER**  
**SECOND YEAR B.Sc., DEGREE EXAMINATION**  
**SEMESTER-IV**  
**CHEMISTRY COURSE V: INORGANIC & PHYSICAL CHEMISTRY**

Time: 3 hours

Maximum Marks: 75

**PART- A** 5 X 5 = 25 Marks

Answer any **FIVE** of the following questions. Each carries **FIVE** marks

1. Write note on Jahn-Teller distortion.
2. Explain Labile & inert complexes.
3. Explain Job's method for determination of composition of complex.
4. Explain Thermodynamic derivation of Gibb's phase rule.
5. Explain any two conductometric titrations.
6. Write note on Fuel Cells with examples and applications.
7. What is enzyme catalysis? Write any three factors effecting enzyme catalysis.
8. Derive Michaels- Menten equation.

**PART- B**  
Marks

5 X 10 = 50

Answer **ALL** the questions. Each carries **TEN** marks

- 9 (a). Explain Valence Bond theory with Inner and Outer orbital complexes. Write limitations of VBT.

(or)

- (b). Define CFSE. Explain the factors effecting the magnitude of crystal field splitting energy.

- 10 (a). Explain Trans effect. Explain the theories of trans effect and write any two applications of trans effect.

(or)

- (b). (i) Write the biological functions of Haemoglobin and Myoglobin.  
(ii) Write note on use of chelating agents in medicines.

- 11.(a). Define Phase rule and terms involved in it. Explain phase diagram of Pb-Ag system.

(or)

- (b). (i) Explain phase diagram for NaCl-water system.

(ii) Explain briefly about Freezing mixtures.

12.(a). Define Transport number. Write experimental method for the determination of transport number by Hittorf method.

(or)

(b).(i) Define single electrode potential.

(ii) Explain four types of electrodes with examples.

13.(a). Explain general methods for determination of order of a reaction.

(or)

(b).Explain Collision theory and Activated complex theory of bimolecular reactions.

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## **SUBJECT EXPERTS**

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