

**P.R. GOVERNMENT DEGREE COLLEGE (A), KAKINADA**  
**DEPARTMENT OF CHEMISTRY BOARD OF STUDIES: 2021-22**

**SECOND YEAR, SEMESTER– IV**

**Paper IV- INORGANIC, ORGANIC & PHYSICAL CHEMISTRY**  
**60 h (4 h / w)**

**Course Outcomes:**

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

**UNIT I:**

**Organ metallic Compounds:**

Definition and classification of organometallic compounds on the basis of bond type, Concept of hapticity of organic ligands. 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 behavior of carbon monoxide.

**Additional Input:** Synergic effects (VB approach) - (MO diagram of CO can be referred to for synergic effect to IR frequencies).

**UNIT II:**

**Carbohydrates:**

Occurrence, classification and their biological importance, Monosaccharides: Constitution and absolute configuration glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth Projection and Conformational Structures; Interconversions of aldoses and ketoses; Kiliani-Fischer synthesis and Ruff degradation.

**Additional Input:** Disaccharides– Elementary Treatment of Maltose, lactose and sucrose.

**UNIT III:**

**Amino acids and proteins:**

Introduction: Definition of Amino acids, classification of Amino acids into alpha, beta, and gamma amino acids. Natural and essential amino acids - definition and examples, classification of alpha amino acids into acidic, basic and neutral amino acids with examples. Methods of synthesis:

General methods of synthesis of alpha amino acids (specific examples - Glycine, Alanine and valine) 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).

### **Heterocyclic Compounds:**

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

**Additional Input:** Structure and nomenclature of peptides and proteins.

## **UNIT IV:**

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

Preparation, properties and important reactions of nitro compounds, amines and diazonium salts.

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

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

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

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

Properties: Physical properties, Basicity of amines: Effect of substituent, solvent and steric effects. Distinction between Primary, secondary and tertiary amines using 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.

**Additional Input:** Hofmann-elimination reaction and Cope elimination.

## **UNIT V:**

### **Photochemistry:**

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

**Thermodynamics:**

The first law of thermodynamics-statement, definition of internal energy and enthalpy, Heat capacities and their relationship, Joule-Thomson effect- coefficient, Calculation of work for the expansion of perfect gas under isothermal and adiabatic conditions for reversible processes, State function. Temperature dependence of enthalpy of formation- Kirchoff 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.

**Additional Input:** Entropy changes in spontaneous and equilibrium processes.

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

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

**Course Outcomes:**

1. Use glassware, equipment and chemicals and follow experimental procedures in the laboratory
2. Determine melting and boiling points of organic compounds
3. Understand 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

**P. R. GOVERNMENT COLLEGE, KAKINADA**  
**MODEL PAPER FOR SEMESTER – IV (CHEMISTRY)**  
**Paper IV (INORGANIC, ORGANIC & PHYSICAL CHEMISTRY)**

**Duration: 2hrs.30 Min**

**Max. Marks: 60**

**PART- A**

Answer any Four of the following questions. Each carries FIVE marks      4 X 5 = 20 Marks

1. Question from Unit –I
2. Question from Unit –II
3. Question from Unit –III
4. Question from Unit – III
5. Question from Unit –IV
6. Question from Unit – IV
7. Question from Unit – V
8. Question from Unit – V

**PART- B**

Answer ALL the questions. Each carries TEN marks

4 X 10 = 40 Marks

9. Question from Unit –I  
(OR)

Question from Unit –I

10. Question from Unit –II  
(OR)

Question from Unit – II

11. Question from Unit –III  
(OR)

Question from Unit – IV

12. Question from Unit – V  
(OR)

Question from Unit – V

## **WEIGHTAGE TO THE COURSE CONTENT**

**Second Year Semester - IV**

### **INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY - IV**

<b>Sl. No.</b>	<b>COURSE CONTENT</b>	<b>ESSAY</b>	<b>SHORT</b>	<b>Total Marks</b>
1	UNIT - I	2	1	25
2	UNIT - II	2	1	25
3	UNIT - III	1	2	20
4	UNIT - IV	1	2	20
5	UNIT - V	2	2	30
<b>Total</b>		<b>8</b>	<b>8</b>	<b>120</b>

**P.R. GOVERNMENT DEGREE COLLEGE (A), KAKINADA**  
**DEPARTMENT OF CHEMISTRY BOARD OF STUDIES: 2021-22**

**SECOND YEAR, SEMESTER– IV**

**Paper: IV- Inorganic, Organic and Physical Chemistry**

**Question Bank**

**Unit-I**

**Essay Questions**

1. What is Organ metallic Compounds? Explain the classification of organ metallic Compounds?
2. Write the preparation of mono and binuclear carbonyl Compounds?

**Short Answer Questions**

1. Define 18 electron rule. Explain with example .
2. Write the Concept of hapticity of organic ligands.

**Unit-II**

**Essay Questions**

1. Explain
  - a) Killiani fisher synthesis
  - b) Ruff degradation
2. Explain Inter-conversion of
  - a) aldohexose to ketohexose.
  - b) Ketohexose to aldohexose.
3. Write about Constitution and absolute configuration glucose?

**Short Answer Questions**

1. Explain Mutarotation.
2. Define Epimers and Anomers and give examples.

**Unit-III**

**Essay Questions**

1. Explain the classifications of Amino Acids. Preparation of amino acids.
2. Write any two methods of Preparations of pyrrole, Furan and Thiophene?

**Short Answer Questions**

1. Explain electrophilic substitution reactions in furan?
2. Write about Diels Alder reaction in furan?
3. What are Essential and Non Essential amino acids give examples?
4. Write about Zwitter ion?

## **Unit-IV**

### **Essay Questions**

1. Write the Preparation and properties of Nitroalkanes.
2. Write note on
  - a) Nef
  - b) Michael
  - c) Mannich
3. Explain Hinsberg method of separation of primary, Secondary, Tertiary Amines.
4. Write about Hoffmann bromide reaction with mechanism.

### **Short Answer Questions**

1. Explain Basic nature of amines.
2. Explain Tautomerism of nitroalkanes?
3. What is Carbylamines Reaction?
4. Explain Halogenation of nitrohydrocarbons?

## **Unit-V**

### **Essay Questions**

1. Explain Jablonski diagram of various processes occurring in Photo Chemistry?
2. What is Quantum yield? Explain Quantum yield of the reaction between  $H_2$  and  $Cl_2$ ?
3. State and explain first law of thermodynamics?
4. Derive Kirchhoff's equation.
5. What is Carnot cycle? Explain Efficiency of Heat Engine by Carnot cycle?

### **Short Answer Questions**

1. Explain Laws of photochemistry?
2. Explain Fluorescence and Phosphorescence?
3. Explain Concept of Entropy?
4. Explain Joule Thomson Effect?



**P.R. GOVERNMENT DEGREE COLLEGE (A), KAKINADA**  
**DEPARTMENT OF CHEMISTRY BOARD OF STUDIES: 2021-22**  
**SECOND YEAR, SEMESTER– IV**  
**Paper V- (INORGANIC & PHYSICAL CHEMISTRY) 60 h (4 h / w)**

**INORGANIC CHEMISTRY**

**UNIT I:**

**Coordination Chemistry:**

IUPAC nomenclature of coordination compounds, Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Valence Bond Theory (VBT): Inner and outer orbital complexes. Limitations of VBT, Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry, Factors affecting the magnitude of crystal field splitting energy.

**Additional Input:** Comparison of CFSE for Octahedral and Tetrahedral complexes.

**UNIT II:**

**1. Inorganic Reaction Mechanism:**

Introduction to inorganic reaction mechanisms. Concept of reaction pathways, transition state, intermediate and activated complex. Labile and inert complexes, ligand substitution reactions -S<sub>N</sub>1 and S<sub>N</sub>2, Substitution reactions in square planar complexes, Trans-effect, theories of trans effect and its applications

**2. Stability of metal complexes:** Thermodynamic stability and kinetic stability, factors affecting the stability of metal complexes, chelate effect, determination of composition of complex by Job's method.

**3. Bioinorganic Chemistry:**

Metal ions present in biological systems, classification of elements according to their action in biological system. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cis-platin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin

**Additional Input:** Geochemical effect on the distribution of metals, Sodium / K – pump, Myoglobin.

## **PHYSICAL CHEMISTRY**

### **UNIT-III:**

#### **Phase rule:**

Concept of phase, components, degrees of freedom. Thermodynamic derivation of Gibbs phase rule. Phase diagram of one component system - water system, Study of Phase diagrams of Simple eutectic systems i) Pb-Ag system, desilverisation of lead ii) NaCl-Water system, freezing mixtures.

### **UNIT IV:**

#### **Electrochemistry:**

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

**Additional Input:** Applications of EMF measurements - Potentiometric titrations.

### **UNIT V:**

#### **Chemical Kinetics:**

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half-life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

**Additional Input:** Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.

**REFERENCE BOOKS:**

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

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

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

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

**Course Outcomes:**

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.

**P. R. GOVERNMENT COLLEGE, KAKINADA**  
**MODEL PAPER FOR SEMESTER – IV (CHEMISTRY)**  
**Paper V (INORGANIC & PHYSICAL CHEMISTRY)**

**Duration: 2hrs.30 Min**

**Max. Marks: 60**

**PART- A**

Answer any Four of the following questions. Each carries FIVE marks      4 X 5 = 20 Marks

1. Question from Unit –I
2. Question from Unit –II
3. Question from Unit –II
4. Question from Unit – III
5. Question from Unit –IV
6. Question from Unit – IV
7. Question from Unit – V
8. Question from Unit – V

**PART- B**

Answer ALL the questions. Each carries TEN marks

4 X 10 = 40 Marks

9. Question from Unit –I  
(OR)

Question from Unit –I

10. Question from Unit –II  
(OR)

Question from Unit – II

11. Question from Unit –III  
(OR)

Question from Unit – IV

12. Question from Unit – V  
(OR)

Question from Unit – V

## **WEIGHTAGE TO THE COURSE CONTENT**

### **Second Year Semester - IV**

#### **INORGANIC AND PHYSICAL CHEMISTRY - V**

<b>Sl. No.</b>	<b>COURSE CONTENT</b>	<b>ESSAY</b>	<b>SHORT</b>	<b>TOTAL MARKS</b>
1	UNIT - I	2	1	25
2	UNIT - II	2	2	30
3	UNIT - III	1	1	15
4	UNIT - IV	1	2	20
5	UNIT - V	2	2	30
<b>Total</b>		<b>8</b>	<b>8</b>	<b>120</b>

**P.R. GOVERNMENT DEGREE COLLEGE (A), KAKINADA**  
**DEPARTMENT OF CHEMISTRY BOARD OF STUDIES: 2021-22**

**SECOND YEAR, SEMESTER– IV**

**Paper: V- Inorganic and Physical Chemistry**

**Question Bank**

**Unit-I**

**Essay Questions**

1. Explain the Geometry and Magnetic Properties of any two of the following
  - a)  $[\text{Co}(\text{NH}_3)_6]^{+3}$
  - b)  $[\text{Fe}(\text{CN})_6]^{-4}$
  - c)  $[\text{Cr}(\text{NH}_3)_6]^{+3}$
  - d)  $[\text{Ni}(\text{CO})_4]$
  - e)  $[\text{Cu}(\text{NH}_3)_4]^{+2}$
  - f)  $[\text{COF}_6]^{-3}$
2. Complex compounds based on valence Bond theory.
3. Discuss the salient features of crystal field theory. Explain the Crystal field splitting of d-orbitals in Octahedral, complexes?
4. Explain Crystal Field theory in Tetrahedral and Square Planar Complexes?
5. Explain the different types of Structural isomerism exhibited by complexes with examples?

**Short Answer Questions**

1. Explain High spin and Low spin complexes with examples.
2. What is a chelating? Give two examples.
3. What is meant by CFSE? Give two examples?
4. Define Stereoisomerism? Give two examples

**Unit-II**

**Essay Questions**

1. Explain determination of composition of complex by job's method.
2. Explain the factors affecting the stability of complexes.
3. Explain the mechanism of ligand substitution reactions with examples.
4. Explain the structure and function of Hemoglobin?

**Short Answer Questions**

1. What is Trans effect? Write its applications?
2. What are labile and inert complexes? Give examples.
3. Write the toxicity of Pb and Hg?

**Unit-III**

**Essay Questions**

1. State Phase rule and explain the terms involved in phase rule?
2. Explain the phase diagram of Pb-Ag system?

**Short Answer Questions**

1. Write notes on freezing mixtures?
2. What is congruent and incongruent melting point-Give one example each?

## **Unit-IV**

### **Essay Questions**

1. Define transport number? Determine the Transport number by Hittorf's method.
2. Explain the Debye-Huckel-Onsager equation for strong electrolytes.
3. Explain about Conductometric titrations? with examples

### **Short Answer Questions**

1. State and explain Nernst equation.
2. Explain Kohlrausch's law of independent migration of ions.
3. Define Molar Conductance and specific conductance
4. Define Equivalent conductance Explain variation of equivalent conductance with dilution.

## **Unit-V**

### **Essay Questions**

1. Define First order reaction? Derive rate Constant of First order reaction. Write the units.
2. Define Second order reaction? Derive rate Constant of Second order reaction. Write the units.
3. Define order of a reaction. Explain any three methods for the determination of order of a reaction.

### **Short Answer Questions**

1. Write about Zero order reaction.
2. Write about Half-life period of first order reaction?
3. Define molecularity and order of reaction and write the differences of them.
4. Write any three factors effecting the rate of reaction