## 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 photo chemical reactions.
2. To understand the concept of quantum efficiency and mechanism of photochemical reactions.

## UNIT - I

**Organo metallic Compounds 8h**

Definition and classification of organo metallic Compounds on the basis of bond type, Concept of hapticity of organic ligands. Metal carbonyls: 18electronrule, electron count of mononuclear, poly nuclear and substituted metal carbonyls of Fe and Co. Pi-acceptor

behaviour of carbon monoxide. Synergic effects (VB approach)

## 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; Inter conversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;

## 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).

## 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 - electrophillic substitution at 2 or 5 position, Halogenation, Nitration and Sulphonation under mild conditions - Diels Alder reaction in furan.

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

## UNIT- IV

**Nitrogen Containing Functional Groups**

Preparation, properties and important reactions of nitro compounds, amines and diazoniumsalts.

## Nitro hydrocarbons 3h

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

## 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 diazoniumsalts including preparation of arenes, haloarenes, phenols, and 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- 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, Jablanski 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- 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. Entropy changes in spontaneous and equilibrium processes.

## Co-curricular activities and Assessment Methods

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

## 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 Cp – Cv = R

**PART- B** 5 X 10 = 50 Marks

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

1. (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.

1. (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)

1. Discuss the aromatic character of Furan, Thiophene and Pyrrole. 12.(a). Write the mechanism for the following.
   1. Nef reaction (ii) Mannich reaction (or)

(b).(i) Explain Hinsberg separation of amines.

* 1. 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 their use in structure determination.

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| --- | --- | --- |
| **INORGANIC CHEMISTRY**  **UNIT –I** |  | **26 h** |
| **Coordination Chemistry**  IUPAC nomenclature of coordination | compounds, Structural | **12 h**  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, Spectro chemical 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, ligand substitution reactions SN1 and SN2, Substitution reactions in square planar complexes, Trans-effect, theories of trans effect and its applications

## 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

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.

## PHYSICAL CHEMISTRY 34 h

**UNIT-III**

## 1 .Phase rule 6h

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, de silverisation 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-Onsagar'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).

**Co-curricular activities and Assessment Methods**

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

## SEMESTER - IV

**Course V LABORATORY COURSE 30**hrs (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 CH3COOH Solution using standard NaOH solution.
3. **Conductometric titration**- Determination of concentration of CH3COOH and HCl in a mixture using standard NaOH solution.
4. **Potentiometric titration**- Determination of Fe (II) using standard K2Cr2O7 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** 5 X 10 = 50

Marks

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

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

(or)

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

1. (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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# Course 6-D: Environmental Chemistry

(Skill Enhancement Course (Elective), Credits -05 Max Marks: 100+50

# 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.

1. Engage in simple and advanced analytical tools used to measure the different types of pollution.
   1. Explain the energy crisis and different aspects of sustainability.
   2. Analyze key ethical challenges concerning biodiversity and understand the moral principles, goals and virtues important for guiding decisions that affect Earth’s plant and animal life.

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

# UNIT-I Introduction 10h

Environment Definition – Concept of Environmental chemistry- Scope and importance of environment in nowadays – Nomenclature of environmental chemistry – Segments of environment– Effects of human activities on environment – Natural resources–Renewable Resources–Solar and biomass energy and Nonrenewable resources

# UNIT-II

**Air Pollution 10h**

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

# UNIT-III

**Water pollution 10h**

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

**UNIT-IV**

# Chemical Toxicology 10h

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 10h 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).

# Biodiversity

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

# Course6-D: Environmental Chemistry – Practical syllabus

**Lab work-Skills 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. Analyse water and soil samples.

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

* 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
     1. 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 Ca+2 and Mg +2 in soil sample by flame photometry.
  7. Determination of PH in soil samples using pH metry.

# 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.

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

# UNIT-I Green Chemistry: Part- I 10 hrs

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

1. Rearrangements (100% atom economic), ii) Addition reaction (100% atom economic). Organic reactions by Sonication method: apparatus required and examples of sonochemical reactions (Heck, Hunds dicker and Wittig reactions).

# UNIT- II Green Chemistry: Part- II 10 hrs

* 1. **Selection of solvent:**

1. Aqueous phase reactions
2. Reactions in ionic liquids, Heck reaction, Suzuki reactions, epoxidation. iii)Solid supported synthesis
   1. Green energy and sustainability.

# UNIT-III Microwave and Ultrasound assisted green synthesis: 10 hrs

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 10 hrs.

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

1. Green synthesis of the following compounds: adipic acid, catechol, disodium menudo acetate (alternative Strecker’s synthesis)
2. Microwave assisted reaction in water –Hoffmann elimination – methyl benzoate to benzoic acid – oxidation of toluene and alcohols–microwave assisted reactions in organic solvents. Diels-Alder reactions and de carboxylation reaction.

# UNIT – V Nanotechnology in Green chemistry 10 hrs

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

# Lab work - 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. Demonstrate skills in the preparation of Nanomaterials.
  4. Acquire skills in Microwave assisted organic synthesis.
  5. Perform some applications of Nanomaterials.

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

* 1. Identification of various equipment in the laboratory.
  2. Acetylation of 10 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 adipicacid
  6. Preparation and characterization of biodiesel from vegetable oil/ waste cooking oil
  7. Preparation and characterization of Nanoparticles of gold using tea leaves.
  8. Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.
  9. Photo reduction of Benzophenone to Benzopinacol in the presence of sunlight.