**M.Sc. Chemistry**
**Open elective paper (MSc/Chem/9/OEC1)**
**Basic Concepts of Chemistry**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Able to discuss about the newly discovered elements and their utility in periodic table.
CO2 Apply the knowledge of hybridisation and tell the structure of molecules and nomenclature about organic molecules & discuss about delocalization of electrons.
CO3 Demonstrate the principle and applications of chromatographic methods.
CO4 Describe the corrosion, its types and prevention and to study types of cells and batteries along with introduction to lead storage battery and solar cells, fuel cells.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**The Periodic Table-History and Developments**

Overview of the periodic system, discoverers of the periodic system, quantitative relationships among the elements and origin of periodic table, the acceptance of Mendeleev's periodic table, Moseley's law and periodic table, radioactivity, atomic number and isotopy, transuranium elements, newly discovered elements and completion of periodic table.

## UNIT-II

**Introduction to Organic Chemistry**

VSEPR theory, Molecular Orbital Theory.
Concept of Hybridisation & structure of organic molecules like ethane, ethylene and ethyne. Preliminary idea of nomenclature of simple organic molecules Delocalized chemical bonding-conjugation, resonance.
Types of reactions and attacking reagents.

## UNIT-III

**Chromatography**

Introduction, Classification of chromatographic methods; Adsorption and Partition Chromatography (Column, Paper and Thin Layer Chromatography), Applications of chromatography.

## UNIT-IV

**Introduction to Physical Chemistry**

Cells and Battery: Types of cells and reactions occurring in cells, Solar cells, Fuel cells, Lead storage battery.

Corrosion: Theory/Principles of Corrosion, Electrochemical theory, Types and factors affecting corrosion, protection from corrosion.

**Mapping of Paper No. MSc/Chem/9/OEC1**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | W | S | S | M | S | S | S | S | S |
| **CO2** | S | S | S | W | S | S | S | S | S | M | S | S |
| **CO3** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Inorganic chemistry, Puri, Sharma, Kalia.
2. Physical Chemistry, Puri, Sharma, Pathania.
3. The periodic table: its story and its significance, Eric R. Scerri.
4. Organic Chemistry, Morrison & Boyd.

**M.Sc. Chemistry**
**Open elective paper (MSc/Chem/9/OEC2)**
**Environmental and Analytical Chemistry**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Able to describe the hydrological cycle of water, water pollution, water quality parameter and standards.
CO2 Illustrate the chemical composition of atmosphere and apply in chemistry of air pollution and control.
CO3 Recognize the toxic effects of different elements.
CO4 Apply the knowledge of food analysis in practical problems.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Hydrosphere**

Hydrological cycle of water, Water pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters – dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards.

## UNIT-II

**Atmosphere**

Chemical composition of atmosphere – particles, ions and radicals and their formation, Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S and their effect, air pollution controls and their chemistry.

## UNIT-III

**Toxicology**

Definition of toxicology, its history, scope and literature, Dose-response relationship. Absorption, Distribution and excretion of toxic materials. Toxicity by metal ions, (like Pb, Hg, Al, Ni, As), Organic toxicants such as halogenated hydrocarbons, pesticides and solvents, Chemical carcinogens.

## UNIT-IV

**Analysis of Food**

Importance of Food analysis, Biomolecules- Fats, Carbohydrates (structures, uses, different types), Vitamins (uses, deficiency diseases, types of vitamins). Determination of approximate composition of fat & carbohydrates.

**Mapping of Paper No. MSc/Chem/9/OEC2**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO2** | S | S | S | S | S | S | S | S | S | M | S | S |
| **CO3** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Environmental Chemistry; A. K. De, Wiley Eastern.
2. Environmental Pollution Analysis; S. M. Khopkar, Wiley Eastern.
3. Environmental Chemistry; S. K. Banerji: Prentice– Hall.
4. Instrumental methods of Analysis; L. L. Merits, R. H. Willard and J. A. Dean; Van Nostrand-Reinhold.

**M.Sc. Chemistry**
**Open elective paper (MSc/Chem/9/OEC3)**
**Chemistry in Everyday Life**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 Get the knowledge of Polymers, their classification and properties, synthesis of some given polymers.
CO2 Describe the concept of soaps and detergents, their types, and their cleansing action.
CO3 Demonstrate about the colour theories of dyes and differentiate the types of dyes.
CO4 Explain about Food additives.
CO5 Describe the enzymes, their role, properties, models.
CO6 Illustrate basics of medicines and their use in daily life.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Polymer Chemistry**

Polymer basic concepts: monomers, classification of polymers, types of polymerizations, Flame retardant polymers, Thermoplastics and Thermosets.

Some specific polymers and their application: Polyamides, Polyesters, Synthetic rubber, natural rubber, Teflon, PMMA, High density and low-density polymer, plasticizers.

## UNIT-II

**Soaps & Detergents**

Chemical composition, Types of Detergents, constitution and cleaning action of the soap and detergents. Difference between soaps and detergents.

**Dyes**

An introduction of dyes, different types of dyes, Color theory of dyes.

## UNIT – III

**Food Additives**

Artificial sweeteners, preservatives, colour additives, rancidity.

**Enzymes**

Introduction, properties, Fischer's lock and key model and Koshland's induced fit hypothesis, Cofactors as derived from vitamins, Coenzymes, Prosthetic groups, Apoenzymes.

## UNIT – IV

**Medicinal Chemistry**

Definition of Drug/medicine, Generic and trade names, Therapeutic index, $LD_{50}$ and $ED_{50}$, Different categories of Medicines like antipyretics, anti-inflammatory, antibiotics, anti-viral, anti-allergic, anta-acids, anti-malarial, tranquilizers with their examples.

**Mapping of Paper No. MSc/Chem/9/OEC3**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | S | S | S | S | S | S |
| **CO2** | S | S | S | S | M | S | S | W | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO5** | S | S | S | S | M | S | S | S | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Polymer Chemistry, Billmayer.
2. Polymer Chemistry, Gowarikar.
3. Principles of Polymerization, Geroge Odian.
4. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
5. Burger's Medicinal Chemistry and Drug Discovery, Vol-I, Ed. M.E.Wolf, John Wiley.
6. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/CC1**
**Inorganic Chemistry-I**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 Describe advanced symmetry concepts of chemical molecules and its applications.
CO2 Able to analyze the axis, plane, center and point group, polarity, dipole moment, product of symmetry operation and character table of chemical compounds.
CO3 Explains about VBT, crystal field theory and its effects in coordination complexes.
CO4 Apply the concept of molecular orbital theory to tetrahedral square planar and octahedral complexes.
CO5 Demonstrate the factors affecting stability of metal ligand complexes.
CO6 Able to use the various methods for the determination of stability constant.
CO7 Discuss the various possible arrangements of electrons in terms of term of symbols.
CO8 Able to describe the magnetic properties of free ions and calculate magnetic moments.
CO9 Draw the vector diagrams of orbital coupling and spin orbital coupling in $d^1$-$d^9$ states configurations.
CO10 Calculate the spectral terms for $d^1$-$d^9$ metal ions.
CO11 Derive the term symbol for closed subshell.
CO12 Illustrate the Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes ($d^1$-$d^9$ states).

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Symmetry and Group Theory**

Definitions of group, subgroup, relation between orders of a finite groups and its subgroups, Symmetry elements, Symmetry point groups, Representation of symmetry operations as matrices (representation for the $C_n$, $C_{nv}$, $C_{nh}$, $D_{nh}$ etc.), Set of symmetry operations of molecules satisfying the conditions of point groups, Multiplication tables.

Representation: Basis of representation, Reducible & Irreducible Representation of point groups. Great orthogonality theorem (without proof) and various relationships derived from it. Derivation of character tables for $C_{2v}$ point group.

## UNIT-II

**Valence Bond Theory**

Outer and inner octahedral complexes, Limitations of VBT, Crystal field theory: Crystal field splitting; Octahedral, Tetragonal, Square planar and Tetrahedral complexes. Distorted octahedral complexes (Jahn Teller effect), Spectrochemical series, Comparison of CFSE value for $d^1$ to $d^9$ ion in terms of orbital splitting (Low and high spin).

Colours of transition metal complexes, Spinel structure, Heat of hydration, Limitations of CFT.

**Molecular Orbital Theory:** Composition of ligand groups, Orbitals, Sigma and pi-molecular orbitals, MOT diagrams.

Charge transfer spectra, angular overlap model as applied to transition metal complexes. Selection rules of d-d transitions, Orgel and Tanabe-Sugano diagrams.

## UNIT-III

**Introduction to Ligands**

Introduction, Stability (kinetic and thermodynamic) of complexes in aqueous solution, Stepwise and overall formation constants of complexes and their determination by spectrophotometric and pH measurement methods. Labile and inert octahedral complexes according to VBT and CFT, Factors affecting lability and stability of complexes (Irving- William order). Chelate effect, Macrocyclic effect, Multidentate ligands. Classification of ligands: π acid ligands, π acceptor character in terms of MOT diagrams, π acid ligands of other groups of periodic tables.

## UNIT-IV

**Polyelectronic Atoms**

Angular momentum, Addition of angular momentum, LS and JJ couplings. Racah parameters and their relationship, Nephelauxetic effect, Determination of ground terms for $d^1$ to $d^{10}$ metal ions; Zeeman and Stark effect.

**Magnetic Properties of Free Ions**

Effect of LS coupling on magnetic properties. Temperature independent paramagnetism (TIP) in terms of crystal field theory (CFT) and molecular orbital theory (MOT). Quenching of orbital momentum by crystal field in complexes in terms of splitting.

**Mapping of Paper No. MSc/Chem/1/CC1**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO2** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | M | S | S | M | S |
| **CO5** | S | S | S | S | S | M | S | S | S | S | S | M |
| **CO6** | S | S | S | S | S | S | M | S | S | S | S | M |
| **CO7** | S | S | S | M | M | S | M | S | S | S | M | S |
| **CO8** | S | S | M | S | M | M | S | S | S | S | S | M |
| **CO9** | S | S | S | S | M | M | M | S | S | S | M | S |
| **CO10** | S | M | S | M | S | M | S | S | M | S | S | M |
| **CO11** | M | S | S | S | S | M | S | S | M | M | S | S |
| **CO12** | S | S | M | S | M | M | S | S | S | S | S | M |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson, 4th Edition.
2. Inorganic Chemistry, J. E. Huheey, 3rd Edition.
3. Inorganic Electronic Spectroscopy, A. B. P. Lever.
4. Introduction to Magnetochemistry, A. Earnshaw.

5. Chemical Application of group theory, F. A. Cotton.
6. Group theory for Chemists, G. Davidson.
7. Introduction to Ligand Fields, B. N. Figgis.
8. Concise Inorganic Chemistry, J. D. Lee 5th Edition.
9. Concise coordination Chemistry, R. Gopalan, V. Ramalingam.
10. Selected Topics in Inorganic Chemistry, W. U. Malik, G. D. Tuli, R. D. Madan.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/CC2**
**Physical Chemistry-I**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Recapitulation of thermodynamic laws.
CO2 Explain thermodynamic functions of mixing (free energy, entropy, volume, and enthalpy), concept of escaping tendency and chemical potential.
CO3 Explain Collision theory of reaction rates, steric requirement, Arrhenius equation and activated complex theory (ACT).
CO4 Demonstrate thermodynamic formulations of activated complex theory.
CO5 Study of photochemical reactions and Rice-Herzfeld mechanism of organic molecules.
CO6 Discuss the various postulates of quantum mechanics.
CO7 Solve Schrödinger equation for a particle in a box and for a one-dimensional box with a finite barrier and its application to quantum mechanical tunnelling.
CO8 Solve Schrödinger equation for linear harmonic oscillator and its solution and Learn about operators and their properties.
CO9 Perform operator mathematics including commutation of operators.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Thermodynamics**

Brief resume of first and second law of thermodynamics. Entropy changes in reversible and irreversible processes; Variation of entropy with temperature, pressure and volume, Entropy concept as a measure of unavailable energy, Free energy functions and their significance, Criteria for spontaneity of a process; Clausius-Clapeyron equation, Law of mass action and its thermodynamic derivation. Third law of thermodynamics (Nernst heat theorem, determination of absolute entropy, unattainability of absolute zero) and its limitation.

## UNIT-II

**Chemical Kinetics**

Methods of determining rate laws, Collision rates, Steric factors, Arrhenius equation and the activated complex theory, Ionic reactions: single and double sphere models, Influence of solvent and ionic strength.

**Chain reactions:** Hydrogen-bromine reaction, Pyrolysis of acetaldehyde, Decompositions of ethane. Photochemical reactions (hydrogen-bromine and hydrogen-chlorine reactions). General treatment of chain reaction (hydrogen- bromine reactions), Apparent activation energy of chain reactions, Chain length, Rice-Herzfeld mechanism of organic molecules decomposition (acetaldehyde).

## UNIT-III

**Quantum Mechanics-I**

The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Eigen functions and Eigen values. Schrödinger equation, free particle, Schrödinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Tunnelling Problem: Tunnelling through a rectangular barrier Schrödinger equation for linear harmonic oscillator and its solution, zero-point energy.

## UNIT-IV

**Quantum Mechanics-II**

Energy levels and wave-functions of Rigid rotator. Hydrogen atom: Complete solution (separation of variables in spherical polar coordinates and its solution). Radial distributions. Angular momentum operators, angular momentum operators in cartesian coordinates, commutation relation between angular momentum operators ($L_x$, $L_y$, $L_z$, $L_2$), total orbital angular momentum and spin angular momentum, commutation relation between components of total orbital angular momentum and spin angular momentum, ladder operators, commutators of [$L_2$, $L_+$] and [$L_2$, $L_-$], application of ladder operators to an eigen function of $L_z$, shapes of atomic orbitals up to d-level and their discussion.

**Mapping of Paper No. MSc/Chem/1/CC2**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO2** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | M | S | M | M | M | M | M |
| **CO5** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO7** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO8** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO9** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Quantum Chemistry, I. M. Levine, Prentice-Hall.
2. Introduction to Quantum Chemistry, A. K.Chandra, Tata Mc Graw Hill.
3. R P. Rastogi & S. S Mishra, Chemical Thermodynamics.
4. S. Glasstone: Thermodynamics for Chemists.
5. Prigogine: Introduction to Thermodynamics of Irreversible processes.
6. Chemical Kinetics, Keith J. Laidler, McGraw Hill.
7. Kinetics and Mechanisms, Arthur A. Frost and R. G.Pearson.
8. Chemical Statistics and Kinetics of solutions, E. A. Huges.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/CC3**
**Organic Chemistry-I**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 Describe reaction intermediates, energy profile diagrams and establish mechanism of organic reaction simultaneously understand effect of structure on reactivity and application of Hammett /Taft equations, Curtin-Hammett principles, Hammond postulates in theoretical treatment of organic reactions.

CO2 Understand mechanistic details of different types of aliphatic nucleophilic substitution reactions and factors affecting them and the terminology involved therein.

CO3 Understand mechanistic details of different types of and factors affecting aliphatic nucleophilic substitution reactions and the terminology involved therein.

CO4 Know mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and application of these in prediction of product formation in various elimination reactions.

CO5 Master stereo-chemical terms, inter-convert stereo-structural formulae of organic molecules, analyze configurations, create stereo-structures and correlate configuration by applying the concept of chemical correlation.

CO6 Describes stability of different configurations and conformations of acyclic and cyclic organic compounds, sugars, decalins.

CO7 Describe the concepts of prochirality, topicity related terms, asymmetric synthesis, its main categories vis-à-vis application of Cram's, Prelog and Horeaus rule, Felkin Ahn Model.

CO8 Understand the concept of aromaticity and explain examples.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT I

**Reaction Mechanism: Structure and Reactivity**

Types of mechanisms, Types of reactions, Thermodynamically and kinetically controlled reactions, Effect of structure on reactivity, Resonance and field effects, Steric effect, and quantitative treatment: The Hammett equation and linear free energy relationship, Substituent ($\sigma$) and reaction constants ($\rho$). Taft equation, Hammond's postulates, Curtin-Hammett principle, Potential energy diagrams, transition states and intermediates.

Methods of determining reaction mechanisms.

Generation, structure, stability, and reactivity of carbocations, carbanions, carbenes and nitrenes.

## UNIT-II

**Aliphatic Nucleophilic Substitution:** The $SN_2$, $SN_1$, SET Mechanisms; Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.

The limiting cases of $SN_1$ and $SN_2$ reactions, detailed mechanistic description and border line mechanisms, Nucleophilicity and solvent effects, Competition between nucleophilicity and basicity, Ambident nucleophiles, Hard and soft nucleophiles and electrophiles, Leaving group

effects, Steric and other substituent effects on substitution and ionization rates, Stereochemistry of nucleophilic substitution, $SN_i$, $SN_i$', $SN_1$, $SN_1$', $SN_2$ and $SN_2$' mechanisms.

**Mechanism of Elimination Reactions**

The $E_1$, $E_{1cB}$ and $E_2$ mechanism, Orientation Effects in elimination reactions, Saytzeff and Hoffman rules, Stereochemistry of $E_2$ elimination reaction and eclipsing effects in $E_2$ eliminations. Dehydration of alcohols, Elimination not involving C–H bonds, Pyrolytic eliminations.

## UNIT-III

**Stereochemistry-I**

Chiral Molecules, Symmetry elements, D-L, R-S, E-Z, and threo & erythro nomenclature, Interconversion of Fischer, Newman, Sawhorse and Flying wedge formulae, Conformational analysis, Enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems., Optical isomerism in allenes, biphenyls (atropisomerism), spiranes. Stereochemistry of decalins, Conformation of sugars.

## UNIT-IV

**Stereochemistry-II**

Elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.

Stereospecific and stereoselective reactions, Concept of prostereo-isomerism and chiral synthesis, Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule, Horeaus rule, Felkin Ahn Model.

**Aromaticity**

Concept of aromaticity, non-aromaticity, anti-aromaticity, homoaromaticity, and psuedo-aromaticity. Aromaticity in charged rings, Huckel-Mobius method for determining aromatic, non-aromatic and anti-aromatic character of annulenes having various π-electron systems.

**Mapping of Paper No. MSc/Chem/1/CC3**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | -- | -- | S | S | S | S |
| **CO2** | S | S | S | S | S | S | -- | M | S | S | S | S |
| **CO3** | S | S | S | S | S | S | -- | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | -- | M | S | S | S | S |
| **CO5** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO6** | S | S | S | S | S | S | -- | M | S | S | S | S |
| **CO7** | S | S | S | S | S | S | -- | M | S | S | S | S |
| **CO8** | S | S | M | S | M | S | M | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Advanced Organic Chemistry: Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. A guidebook to Mechanism in Organic Chemistry, Peter Sykes.
3. Structure and Mechanism in Organic Chemistry, C. K. Ingold.

4. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner.
5. Stereochemistry of Organic Compounds, D. Nasipuri.
6. Stereochemistry of Organic compounds, P. S. Kalsi.
7. Stereochemistry of Carbon compounds, E. L. Eliel.
8. Mechanism and Theory in Organic Chemistry, Lowry and Richardson.
9. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg.
10. Organic Chemistry, T.W.G. Solomon, W.B. Fryhl and S.A. Snyder, Wiley.
11. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/NC1**
**Mathematics for Chemists**

**NC** **Total Marks = 50**
**Time: 2 Hrs.** **40 (EM) + 10 (IA)**

**Course Outcomes:**

CO1 Explain definitions of vectors, representation and properties of vectors.
CO2 Perform vector mathematical operations.
CO3 Explain scalar and vector products of vectors.
CO4 Describe the definition and properties of matrices and determinants.
CO5 Demonstrate matrix mathematics.
CO6 Apply and analyze linear equations using matrices.
CO7 Describe rules of differentiation and be able to find out the derivative of a function by applying various methods of differentiation.
CO8 Describe rules and methods of integration.
CO9 Perform integration between limits and apply in chemistry.

**Note for the paper setter:** The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

## UNIT – I

### Vectors

Definition and its properties, Examples of scalar and vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors, scalar and vector product.

### Matrices and Determinants

Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, equal matrix, square matrix, diagonal matrix. Addition, subtraction and multiplication by a number, matrix multiplication (order of matrix being 3). Transpose and adjoint of matrix, elementary transformation, Definition of determinant, properties of determinants, evaluation of determinants, solution of linear equations using determinants.

## UNIT – II

### Differential Calculus

Differentiation of standard functions, Theorems relating to the derivative of the sum, difference, product and quotient of functions, Derivative of function of a function (Chain Rule), Derivative of trigonometric & trigonometric composite functions (chain rule), Inverse trigonometric functions, Logarithmic and exponential functions, Logarithmic differentiation.

### Graphical Representation of Equations

Rectangular coordinates, straight lines, slope and intercept of the equation, slope and point equation, two-point equation, parallel lines, points of intersection, distance between two points, change of origin. Examples from problems in chemistry.

**Integral Calculus**

Integral theory, basic rules of integration, methods of integration, viz. algebraic simplifications, integration by substitution, integration by parts, integration by partial fractions, integration between limits, curve sketching, integral as area. Illustration of application in chemistry.

**Mapping of Paper No. MSc/Chem/1/NC1**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO2** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO5** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO7** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO8** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO9** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company.
3. Mathematical Methods for Science Students, G. Stephemen, ELBS.
4. Chemical Thermodynamics, C.E. Reid, Mc Graw Hill.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/NC2**
**Biology for Chemists**

**NC** **Total Marks = 50**
**Time: 2 Hrs.** **40 (EM) + 10 (IA)**

**Course outcomes:**

CO1 Describe and draw the prokaryotic and eukaryotic cell Structure, metabolic processes occurring in cell. Able to discuss the Carbohydrate metabolism-glycolysis, Kreb's cycle, glycogenolysis, glycogenesis pentose phosphate pathway and gluconeogenesis.

CO2 Demonstrate the Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, structural polysaccharides - cellulose and chitin. Storage polysaccharides-starch and glycogen.

CO3 Analyze the structure and functions of fatty acids, triacylglycerols, β-oxidation of fatty acid, Fluid mosaic mode of cell membrane.

CO4 Describe the concept of the amino acids, peptides and proteins. Able to describe the primary, secondary structure of proteins and forces responsible for holding these structures.

CO5 Identifies enzymatic and chemical cleavage of polypeptide chain, sequencing of amino acids in a polypeptide segment, concept of denaturation of proteins.

CO6 Describe and draw the Structure of nucleotides, nucleosides, DNA (Watson-Crick model) RNA and their conformation.

**Note for the paper setter:** The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

## UNIT – I

**Cell Structure and Metabolism**

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic processes - catabolism and anabolism. ATP - the biological energy currency. Carbohydrate metabolism: glycolysis and Kreb's cycle.

**Carbohydrates**

Structure and biological functions of important monosachharides (excluding detailed conformational analysis) and derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars-N-acetylmuramic acid. Disaccharides- sucrose, lactose and maltose.
Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen).

## UNIT – II

**Lipids**

Fatty acids, essential fatty acids, structure and functions of triacylglycerols.
Lipid bilayers, Fluid mosaic model of membrane structure.
Lipid metabolism - β-oxidation of fatty acids.

**Amino-acids, Peptides and Protein**

Peptide bond, Chemical and enzymatic hydrolysis of proteins to peptides, Secondary structure of proteins-α-helix, β-sheet, forces responsible for holding the secondary structures of proteins. Denaturation of Proteins.

**Nucleic Acids and Genetic Code**

Structure and functions of nucleotides, nucleosides, DNA (Watson-Crick model, Chargaff's rules) and RNA (m-RNA, r-RNA and t-RNA).

Genetic code and its characteristics.

**Mapping of Paper No. MSc/Chem/1/NC2**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO 2** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO 3** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO 4** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO 5** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO 6** | S | S | S | S | S | S | M | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/CC4**
**Inorganic Chemistry Practical-I**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**
CO1 Explains the basic concept about qualitative analysis.
CO2 Describes the concept of quantitative analysis and its application.
CO3 Separate and quantify the presence of two metal ions in a solution.
CO4 Prepares mentally to face viva-voce.

**Syllabus –**

1. **Qualitative Analysis**

   Identification of rare earth cations including less familiar elements by spot tests assisted by group analysis (6 cations).

2. **Quantitative Analysis**

   Separation of the metal ions and determination of any one of them using volumetric/ gravimetric methods: Cu-Ni, Cu-Zn, Cu-Al, Fe-Ni and analysis of alloys.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**

**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/1/CC4**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | M | S | M | M | M | S | S | S | M | S |
| CO2 | S | S | S | S | M | S | S | S | S | S | S | S |
| CO3 | S | S | S | S | S | S | S | S | S | S | S | S |
| CO4 | S | S | S | S | M | M | W | S | M | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. A textbook of Qualitative Inorganic Chemistry, A. I. Vogel.
2. A Textbook of Macro and Semi-micro–Quantitative Analysis, A. I. Vogel, Orient Longman.
3. A Vogel's Textbook of Quantitative Inorganic Analysis, J. Bassett, R. C.
4. Denney, G. B. Jaffery and J. Menaham, Longman, London.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/CC5**
**Physical Chemistry Practical-I**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Determine extent of adsorption and verify Freundlich and Langmuir adsorption isotherms.

CO2 Determine the molecular weight of a given substance i.e., naphthalene and biphenyl by Rast method.

CO3 Understand the concept of surface tension and its determination for various organic solvents.

CO4 Know the concept of viscosity and its determination.

CO5 Determine the viscosity averaged molar mass of a polymer.

CO6 Determine the partition coefficient of a solute between two immiscible solvents by using distribution law.

**Syllabus -**

**Adsorption**

1. To determine the adsorption isotherms of acetic acid from aqueous solution by charcoal.
2. To study the adsorption of $I_2$ from alcoholic solution by charcoal.
3. To investigate the adsorption of oxalic acid from aqueous solution by activated charcoal and to examine the validity of Freundlich & Langmuir's adsorption isotherms.

**Molecular Weight of Polymers**

1. To determine the molecular weight of a given polymeric solution by viscosity method.
2. To determine the molecular weight of a given substance i.e., naphthalene and biphenyl by Rast method.

**Surface Tension/Interfacial Tension**

1. To find surface tension/interfacial tension between two immiscible liquids.
2. To determine surface tension of given liquid like $CCl_4$ by number drop method using stalagmometer.
3. To determine the percentage composition of a given mixture of two liquids say $CCl_4$ and Toluene by surface tension method.

**Viscosity**

1. To find viscosity of unknown liquids by Ostwald's viscometer method.
2. To determine the percentage composition of given unknown mixture by viscosity method.
3. To determine the coefficient of viscosity of a liquid such as ethyl acetate with the help of Ostwald viscometer.

**Distribution Law**

1. To study the distribution of benzoic acid between benzene and water at room temperature and show that benzoic acid dimerizes in benzene.
2. To determine the distribution coefficient of $I_2$ between organic liquid and water at a given temperature.
3. Study of distribution coefficient of succinic acid between organic liquid and $H_2O$ at a given temp.

**Note:** Any experiment can be introduced or deleted in the practical class based on availability of instruments/chemicals.

**Experiment & Written part** **Marks: 70**

**Lab record** **Marks: 10**

**Viva-voce** **Marks: 20**

**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/1/CC5**

| Course Outcome | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO2** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | M | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO6** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Zindley's Practical Physical Chemistry, B. P. Levitt, Longman.
2. Experimental Physical Chemistry, R. C. Das, B. Behara, Tata McGraw Hill.
3. Practical Physical Chemistry, A. M. James, F. E. Prichard.
4. Practical Physical Chemistry, S. R. Palit, S. K. De.
5. Experiments in Physical Chemistry, Shoemaker and Gailand, McGraw Hill.
6. Practical Physical Chemistry, B. Viswanathan, P. S. Raghavan.

**M.Sc. Chemistry (1st Sem.)**
**MSc/Chem/1/CC6**
**Organic Chemistry Practical-I**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Demonstrate the basic principle and apply the techniques of separation of binary organic mixture.
CO2 Analyze qualitatively the presence of extra elements and functional groups in the binary organic mixture along with understanding of chemical reaction involved.
CO3 Differentiate between aromatic/aliphatic, saturated/unsaturated, hydrocarbon/heterocycles.
CO4 Understand and develop the capabilities of preparing derivatives of different organic compounds bearing various organic functionalities.
CO5 Identify the significance of melting point, mixed melting point, boiling point in identification of organic compounds.
CO6 Demonstrate the basic laboratory & purification techniques in organic chemistry.
CO7 Develop the skill of performing experiments and analyzing data to evaluate results.
CO8 Develop the ability to compile interpreted information in the form of lab record.
CO9 Prepare mentally and academically to face viva-voce.

**Syllabus –**

**Demonstrations of Laboratory & Purification techniques-**Refluxing, Purification of solvents and reagents using various techniques like crystallization, distillation, fractional distillation, Drying of solvents, sublimation etc.
**Demonstrations of separation of solid-solid binary mixtures:** using $H_2O$, HCl, NaOH, $NaHCO_3$, Ether or other reagent as may be necessary along with required conditions for their use.
**Systematic identification** of mixtures of pure organic compounds: separation and identification of simple binary mixtures having acidic, basic and neutral components. Preparation of their derivatives, determination of b.p./m.p. for components and their derivatives.
**Note:** Any other experiment be added/substituted as per requirement and availability of chemicals.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/1/CC6**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | M | S | M | S | M | M | S | S | S | M |
| CO2 | S | S | M | S | M | S | S | M | S | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | S | S | M | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | M | S | M | S | S | M | S | S | S | S |
| **CO5** | M | M | S | S | W | M | M | M | S | S | S | M |
| **CO6** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO7** | M | S | S | S | S | S | W | W | S | S | S | S |
| **CO8** | M | M | M | M | M | S | W | W | S | S | S | S |
| **CO9** | S | S | S | S | M | M | W | S | M | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. A Handbook of Organic Analysis Qualitative and Quantitative by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.) Ltd. London, 1975).
2. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. A Textbook of Practical Organic Chemistry including Qualitative Organic Analysis by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, CBS Publishers & Distributors.
5. Vogel's Textbook of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

**M.Sc. Chemistry (2nd Sem.)**
**MSc/Chem/2/CC7**
**Inorganic Chemistry-II**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Understand the MO Diagram of Diatomic molecules, especially of Carbonyl.
CO2 Describe Magnetic and IR studies of Carbonyl complexes.
CO3 Know the HSAB concept with their applications.
CO4 Understand Mulliken symbols and describe applications of group theory in analysis of molecular structure of different molecules.
CO5 Know the concepts of nuclear and radiochemistry and discuss the structure and functioning of various counters use in radiochemistry.
CO6 Describe the radiotracer technique, activation analysis and its applications in various aspects.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Introduction to Metal Complexes**

Metal carbonyls, M.O. diagram of CO, nitrosyls and dinitrogen complexes, Orbital diagrams of bi and trinuclear carbonyls, Semi-bridging in metal carbonyls and nitrosyls. Magnetic, IR evidence of their structures, $\pi$ - acidity and softness in terms of HSAB principle, Symbiosis.

## UNIT-II

**Applications of group Theory**

Mülliken symbols, Application of group theory in stereochemistry, Molecular vibrations-symmetry aspects of molecular vibrations, selection rules for vibrational absorption, complementary character of IR and Raman spectra (mutual exclusion principle), Application of group theory in analysis of vibrational spectra and prediction of IR and Raman active vibrational modes ($H_2O$, $NH_3$, $CH_4$, $SF_6$).

## UNIT III

**Nuclear Chemistry-I**

Fundamental particles of nucleus (nucleons): Concept of nuclides, representation of nuclides. Isobars and isotopes (specific examples). The size concept of nucleus and atom. The possible forces operating between neutron-neutron, proton-proton and neutron-proton, The magnitude of nuclear forces (short range), Qualitative idea of the stability of nucleus (n/p ratio), Shell and liquid drop models (qualitative ideas), Natural and artificial radioactivity, Disintegration series; Radioactive disintegration rate, Half -life and average life.

## UNIT-IV

**Nuclear Chemistry-II**

Nuclear binding energy, Mass defect, Einstein's mass energy relation, Calculation of mass defect and binding energy, Artificial transmutation, Nuclear reactions: Nuclear fissions, fusion and spallation, Radioactive isotopes, Tracer chemistry, Carbon dating, Some typical applications in industry, agriculture, medicine and bio-chemistry: Therapeutic uses of isotopes. Basic principles and types of nuclear reactors, Scintillation counters, Gieger Muller Counter. Radioactive waste disposal.

**Mapping of Paper No. MSc/Chem/2/CC7**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO2** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO5** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Advanced Inorganic Chemistry, F. A Cotton & G. Wilkinson, 4th Edition.
2. Inorganic Chemistry, J. E. Huheey, 3rd Edition.
3. Inorganic Electronic Spectroscopy, A. B. P. Lever.
4. Introduction to Magnetochemistry, A. Earnshaw.
5. Chemical Application of group theory, F. A. Cotton.
6. Introduction to Ligand Fields, B. N. Figgis.
7. Essentials of Nuclear Chemistry, H. J. Arinikar, 4th edition.
8. Radiochemistry and Nuclear Chemistry, G. Choppin, J. Liljenzin and J. Rydberg.

**M.Sc. Chemistry (2nd Sem.)**
**MSc/Chem/2/CC8**
**Physical Chemistry-II**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 Discuss scope of irreversible thermodynamics.
CO2 Explain phenomenological laws.
CO3 Describe specific laws of entropy production.
CO4 Discuss coupled reactions & unimolecular reactions.
CO5 Determination of partial molar volume, thermodynamic functions of mixing.
CO6 Knowledge about fundamental concepts of phase equilibrium and their applications in studying one and two-component systems including eutectics.
CO7 Understand the concept of fugacity and its determination.
CO8 Basic information of photochemistry and laws of photochemistry.
CO9 Learn about Phosphorescence and fluorescence.
CO10 Discuss Debye-Hückel theory of ion-ion interaction and activity coefficient, its applicability, limitations and its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient.
CO11 Derive D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment) and its modifications for ion-pair formation.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Non-Equilibrium Thermodynamics**

General theory of non-equilibrium processes, Entropy production and entropy flow; Thermodynamic criteria for non-equilibrium states, Entropy production in heat flow, Mass flow, Electric current, Chemical reactions, Saxen`s relation, Onsager's reciprocity relation, Thermomolecular pressure difference, Electro kinetic phenomenon, Coupled reactions.

**Unimolecular Reactions**

Dynamics of unimolecular reactions (Lindemann-Hinshelwood and Rice-Ramsperger-Kassel-Marcus [RRKM] theories of unimolecular reactions.

## UNIT-II

**Partial molar quantities-** Chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of ideal gas mixture (s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential.

**Phase rule, Fugacity and Activity Coefficient**

Phase Rule, Phase diagram for two completely miscible component systems. Concepts of fugacity, fugacity of gases and its determination. Activity and activity coefficient, choice of standard states, dependence of activity on temperature and pressure, determination of activity (i) measurement of vapour pressure, (ii) distribution of solute between two immiscible solvents and (iii) emf measurement.

## UNIT-III

**Photochemistry**

Laws of photochemistry, Frank Condon Principle, quantum yield, quantum efficiency, Jablonskii diagram, photophysical processes, phosphorescence and chemiluminescence, Kinetics of photophysical processes, relaxation time,

emission spectra, environment effect on absorption and emission spectra, Wigner's spin conservation rule. Modes of decay of excited states, quenching of fluorescence, delayed fluorescence, Stern–Volmer equation. Excimer and exciplex formation and decay.

Techniques for the study of transient species in photochemical reactions. Applications of Lasers in photochemical kinetics.

## UNIT-IV

**Electrochemistry**

Debye-Hückel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte.

Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect. D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.

**Mapping of Paper No. MSc/Chem/2/CC8**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO2** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO5** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO7** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO8** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO9** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO10** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO11** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Non-equilibrium Thermodynamics, C. Kalidas.
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Physical Chemistry, G.W. Castellan, Narosa.
4. Electrochemistry, S. Glasstone, Affiliated East-West Press.
5. Chemical Physics, J.C. Slater.

**M.Sc. Chemistry (2nd Sem.)**
**MSc/Chem/2/CC9**
**Organic Chemistry-II**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Describe the concept of aliphatic electrophilic substitution reaction and illustrate the aliphatic electrophilic substitutions mechanisms - $SE_2$, $SE_1$.
CO2 Understands and illustrate the neighbouring group participation, classical and non-classical carbocation and describe the role of non-bonding electrons, sigma, and π-bonds in NGP.
CO3 Describes the concept of carbocations rearrangements and migratory aptitudes.
CO4 Discuss the concept of Aromatic Nucleophilic Substitution by diazonium salts, arynes.
CO5 Describes the mechanisms of Aromatic Electrophilic Substitution and their applications.
CO6 Discuss about the generation, structure, stability, and reactivity of free radicals.
CO7 Know mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and application of these in prediction of product formation in various elimination reactions.
CO8 Able to draw the mechanisms of addition to alkenes and alkynes.
CO9 Describes the reactivity of carbonyl compounds in various reactions & addition to carbonyl group of aldehydes, ketones and acids.
CO10 Describes various name reactions related to ketones and aldehydes.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Aliphatic Electrophilic Substitution**

Bimolecular mechanisms: $SE_2$ and $SE_1$. The $SE_1$ mechanism, Electrophilic substitution accompanied by double bond shifts. Effect of substrates, Leaving group and solvent polarity on the reactivity.

**Neighbouring group participation and carbocation rearrangements**

Anchimeric assistance, Neighbouring Group Participation by non-bonding electrons, sigma and σ -bonds and π bonds, Classical and non-classical carbocations, Carbocation rearrangements: Migratory aptitudes, Wagner-Meerwein rearrangement, Pinacol-pinacolone rearrangement, Dienone-phenol rearrangement, Demjanov rearrangement, Tiffeneau-Demjanov ring expansion.

## UNIT-II

**Nucleophilic Aromatic Substitution**

Mechanism of Nucleophilic substitution in aromatic systems via diazonium ions, by addition-elimination and elimination-addition mechanism (involving arynes); von-Richter rearrangement, Sommelet-Hauser, Stevens rearrangements.

General aspects of generation, structure, stability and reactivity of arynes.

**Aromatic Electrophilic Substitution**

Theoretical treatment of aromatic substitution reactions, the arenium ion mechanism, orientation and reactivity, Structure-reactivity relationship in mono substituted benzene ring, Orientation in other ring systems, Vilsmeier-Haack reaction, Bischler - Napieralski reaction, Pechmann reaction, Houben-Hoesch reaction, Gattermann-Koch reaction.

## UNIT-III

**Free Radicals**: General aspects of generation, structure, stability and reactivity of free radicals, Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, The effect of solvents on reactivity. Halogenations including Allylic halogenation (NBS), auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction & Hundsdiecker reaction.

**Addition to C-C multiple bond**

Mechanism of addition of hydrogen halide, $H_2O$, halogens, HOX and mercuric salt to alkenes and alkynes. Hydroboration of acetylenes, Nucleophilic addition to alkenes, formation of C-C bonds via organoboranes.

## UNIT-IV

**Addition to Carbon-Hetero Multiple Bonds**

General mechanistic considerations and reactivity, Hydration and Addition of Alcohols to Aldehydes, Ketones and Acids. Addition -Elimination Reactions of Ketones and Aldehydes, Reactivity of carbonyl compounds towards Addition.

Mechanism of LAH reduction of carbonyl compounds, acids & esters. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl compounds.

Mechanism of condensation reactions involving enolates – Wittig reaction, Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin, Stobbe reactions, Reformatsky reaction, Michael addition reaction, Dieckmann reaction, Robinson annulation reaction, Cannizzaro reaction, Hydrolysis of esters and amides.

**Mapping of Paper No. MSc/Chem/2/CC9**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | M | M | M | S | M | M | S | S | S | S |
| CO2 | S | S | M | M | M | S | M | M | S | S | S | S |
| CO3 | S | S | M | S | M | S | M | M | S | S | S | S |
| CO4 | S | S | M | S | M | S | M | M | S | S | S | S |
| CO5 | S | S | M | S | M | S | M | M | S | S | S | S |
| CO6 | S | S | M | S | M | S | M | M | S | S | S | S |
| CO7 | S | S | M | S | M | S | M | M | S | S | S | S |
| CO8 | S | S | M | S | M | S | M | M | S | S | S | S |
| CO9 | S | S | M | S | M | S | M | M | S | S | S | S |
| CO10 | S | S | M | S | M | S | M | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Jerry March.
2. A Guidebook to Mechanism in Organic Chemistry, Peter Sykes.
3. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner.
4. Organic Chemistry, Benjamin/Cummings, 2nd edition.
5. Organic Chemistry, McMurry, $2^{nd}$ edition.
6. Organic Chemistry, Solomons, $5^{th}$ edition.
7. Organic Chemistry, Vollhard, W. H. Freeman.
8. Name Reactions: A Collection of Detailed Mechanisms and Synthetic Applications by Jie Jack Li from Springer.
9. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.

**M.Sc. Chemistry (2nd Sem.)**
**MSc/Chem/2/SEC1**
**Computer for Chemists**

**Credits-2** **Total Marks = 50**
**Time: 2 Hrs.** **40 (EM) + 10 (IA)**

**Course outcomes:**

CO1 Describe about the basic functioning of computer, memory devices, storage devices and different generations of computer.
CO2 Get the knowledge of MS-word and apply it.
CO3 Demonstrate how to use MS-Excel, MS-Power Points & making slides and how to apply the formulas.
CO4 Learn about the presentations, chem draw tools and Plotting tools.

**Note for the paper setter:** The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

## UNIT I

**Introduction to Computers and Computing**

Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices, secondary storage. Computer languages. Different types of software, Algorithms and flow charts, Computer Generations.

**Word Processing**

Page setting, formatting a document, searching in document, Bullets and Numbering, Text wrapping, Page break, Insert: table, picture, shapes, smart art, water mark, chart, hyperlink, bookmark, cross reference, header, footer, end note, foot note, page number, text box, table of contents, mathematical and other symbols.

## UNIT-II

**Spreadsheet**

Worksheet and Workbooks, creating a worksheet, Cell formatting, Text wrapping, Merge and Centre, Table formatting, Sorting, Filtering, Searching, insert picture, shapes, graphs, chart, symbols, applying formula and function, Importing data from other sources.

**Power Point Presentation**

Create new slides, setting layout of new slide, insert slide, delete slide, insert table, pictures, shapes, chart, hyperlink, header, footer, slide number, text box, signature and line, data and time, mathematical and other symbols, sound and video, transition and animations, set and present a slide show.

**Practical purpose-**

1. Microsoft package including MS-Word, MS- Power Point, MS-Excel.
2. Plotting/Drawing software: Introduction to Chem Draw & Origin Software & their basic applications in Chemistry: - Linear Plot & Fit, drawing of simple organic molecules & Prediction of $^{1}$H-NMR spectra of some organic molecules.

**Note- IA will be given based on practical performance of the students. No external assessment for the practical purpose. Only theory paper will be sety from the two units and no practical paper will be conducted.**

**Mapping of Paper No. MSc/Chem/2/SEC1**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | W | S | W | W | S | W | W | W | W | W |
| **CO2** | S | S | S | S | M | W | S | W | W | W | S | M |
| **CO3** | S | S | S | S | M | W | S | W | W | W | S | M |
| **CO4** | S | S | S | S | M | W | S | W | W | W | S | M |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Computers and Common Sense, R. Hunt and J. Shelley, Prentice Hall
2. Computational Chemistry, A.C. Norris.
3. An Introduction to Digital Computer Design, V. Rajaraman, T. Radhakrishnan.
4. Computer fundamentals, P.K Sinha and Priti Sinha.
5. A complete guide to Computer Fundamentals, Sudipto Das, Science Press.
6. Computer Fundamentals, Anita Goel, Pearson Education.
7. Computer Fundamentals and Information Technology, Ramesh Bangia, Firewall Media.
8. Computer Fundamentals and Applications, Ashok Arora, Vikas Publishing.

**M.Sc. Chemistry (2nd Sem.)**
**MSc/Chem/2/CC10**
**Inorganic Chemistry Practical-II**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**
CO1 Prepare the sample of various coordination complexes and their spectroscopic study.
CO2 Develop the ability to compile interpreted information in the form of lab record.
CO3 Perform experimentation and evaluate the results.
CO4 Prepare mentally to face viva-voice.

**Syllabus -**

**Preparation of Complexes**

1. Preparation of Chloropentaaminecobalt(III) chloride and its conversion into nitro and nitrite isomers (IR study).
2. Preparation of cis and trans $[Co(en)_2Cl_2]Cl$ (UV-Vis and IR Study).
3. Preparation of Mercury tetraisothiocyanatocobaltate(II) $Hg[Co(NCS)_4]$, Magnetic susceptibility and IR study.
4. Preparation of Sodium hexanitritocobaltate(III), $Na_3[Co(NO_2)_6]$, and its IR interpretation.
5. Preparation of Potassium dioxalatocuprate(II) dihydrate $K_2[Cu(C_2O_4)_2].2H_2O$. (Magnetic susceptibility, ESR, IR and UV-Vis studies).
6. Preparation of cis and trans Potassium dioxalatodiaquochromate(III). Interpretation of their IR and electronic absorption spectral data.
7. Preparation of Iron(II) oxalate and Potassium trioxaltoferrate(III), $K_3[Fe(C_2O_4)_3]$, Interpretation of their magnetic and EPR data.
8. Preparation of Ammonium tetrathiocynatodiammine chromate(III), $NH_4[Cr(SCN)_4(NH_3)_2]$.
9. Preparation of cis and trans isomers of bis-glycinato copper(II) and distinguish them on the basis of IR spectroscopy.
10. Preparation of macrocyclic ligand 5,7,7,12,14,14-hexamethy1-1,4,8,11-tetrazacylotetradeca-4,11-diene dihydrogeniodide, and its complexes with Ni(II).

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/2/CC10**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO2** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Inorganic Synthesis, Book Series Vol 5, Wiley.
2. Practical Inorganic Chemistry, G. Marr, B. W. Rockett Bull. Chem. Soc., Japan 29, (1956) 852.
3. J. Chem. Soc 84, (1962) 3404.
4. P. H. Merrell, F. L. Urbach, M. Arnold, J. Chem. Edu. 54(9), (1977) 580.
5. Practical Inorganic Chemistry: Preparations, reactions and instrumental methods, G. Pass, H. Sutcliffe, springer.

**M.Sc. Chemistry (2nd Sem.)**
**MSc/Chem/2/CC11**
**Physical Chemistry Practical-II**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Determine the molar refractivity of given compounds.
CO2 Study and conduct experiments related to chemical kinetics for the determination of the order and rate constant of the reaction.
CO3 Determine the solubility of an inorganic salts.
CO4 Understand and master the fundamentals of potentiometric experiments.

**Syllabus-**

**Refractometry**

1. Determination of refractive index of simple organic liquids.
2. Variation of refractive index with composition for a mixture of two organic liquids.
3. To determine the molar refractivity of $CH_3OH$, $CH_3COOH$, $CH_3COOC_2H_5$ and $CCl_4$ and calculate the refractive equivalent of C, H and Cl atoms.
4. Find out molar refractivity of benzene, toluene, propyl alcohol, butyl alcohol etc. and $-CH_2-$ group of homologous series.

**Chemical Kinetics**

1. Determination of the rate constant of an ester catalysed by an acid or a base.
2. Study of a second order reaction.
3. Determine the velocity constant of hydrolysis of ethyl acetate using sodium hydroxide solution.

**Solution Chemistry**

1. To determine the solubility of an inorganic salt like KCl, NaCl, $KNO_3$, $NaNO_3$, $K_2SO_4$ etc. in water at different temperature and hence to obtain the solubility curve.
2. To determine the heat of solution of given substance like oxalic acid and benzoic acid by solubility method.

**pH Metry**

1. To determine the strength of strong acid versus strong base using a pH meter.
2. To determine the strength of weak acid versus strong base using a pH meter.
3. Determination of the strength of strong and weak acids in a given mixture using a pH meter.

**Potentiometry**

1. To determine the strength of strong acid versus strong base using a potentiometer.
2. To determine the strength of weak acid versus strong base using a potentiometer.
3. Determination of the strength of strong and weak acids in a given mixture using a potentiometer.
4. To prepare and test the standard reference electrode i.e., calomel electrode or silver chloride electrode.
5. Titrate Mohr's salt against $KMnO_4$ potentiometrically and carry out the titration in reverse order.

**Note:** Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

**Experiment & Written part** **Marks: 70**

**Lab record** **Marks: 10**

**Viva-voce** **Marks: 20**

**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/2/CC11**

| Course Outcome | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | M | - | S | S | S | S |
| **CO2** | S | S | S | S | S | S | M | - | S | S | S | S |
| **CO3** | S | S | S | S | S | S | M | - | S | S | S | S |
| **CO4** | S | S | S | S | S | S | M | - | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings**


1. Zindley's Practical Physical Chemistry, B. P. Levitt, Longman.
2. Experimental Physical Chemistry, R. C. Das, B. Behara, Tata McGraw Hill.
3. Practical Physical Chemistry, A. M. James, F. E. Prichard, Longman.
4. Practical Physical Chemistry, S. R. Palit, S. K. De, Science Book agency.
5. Experiments in Physical Chemistry, Shoemaker and Gailand, McGraw Hill.
6. Practical Physical Chemistry, B. Viswanathan, P. S. Raghavan.

**M.Sc. Chemistry (2nd Sem.)**
**MSc/Chem/2/CC12**
**Organic Chemistry Practical-II**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**
CO1 Describes the concept of stepwise synthesis of a product and their purification.
CO2 Explore various combinations of reactions that can be exploited to form a product.
CO3 Perform experimentation and evaluate the results.
CO4 Develops the ability to compile interpreted information in the form of lab record.
CO5 Prepare mentally to face viva-voce.

**Syllabus -**
**Preparations of Organic compounds involving one, two and three stages:**

1. p-nitroacetanilide from aniline
2. p-bromoacetanilide from aniline
3. Anthranilic acid from phthalic anhydride
4. Eosin from phthalic anhydride
5. m-nitroaniline from Nitrobenzene
6. Sym-tribromobenzene from aniline
7. 2,4-dinitrophenylhydrazine from chlorobenzene
8. 2,5-dihydroxy acetophenone from hydroquinone
9. Benzanilide from Benzophenone
10. Any other multi step reaction as per requirement

**Note:** Purification after each step should preferably be done by using Recrystallization or by TLC.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/2/CC12**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO2** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO3** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO4** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO6** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. A Handbook of Organic Analysis Qualitative and Quantitative by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.) Ltd. London, 1975).
2. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.
3. A Textbook of Practical Organic Chemistry including Qualitative Organic Analysis by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, CBS Publishers & Distributors.
5. Vogel's Textbook of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.
6. Experiments in Organic Chemistry by Louis, F. Fieser, D.C. Heath and Company Boston, 1955.
7. Practical Organic Chemistry by Mann and Saunders.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/CC13**
**Cardinal Principles of Academic Integrity and Publications Ethics**

**Credits-2** **Total Marks = 50**
**Time: 2 Hrs.** **30 (EM) + 20 (IA)**

**Course outcomes:**

CO1 Academic Integrity, Plagiarism (prevention and detection) and UGC regulations.
CO2 Research and Publications ethics and best practices.

**Note for the paper setter:** The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

## Unit I

**Academic Integrity:** Introduction, Academic Integrity Values- Honesty and Trust, Fairness and Respect, Responsibility and Courage, Violations of Academic Integrity-types and consequences, Plagiarism -definition, Plagiarism arising out of misrepresentation-contract cheating, collusion, copying and pasting, recycling, Avoiding Plagiarism through referencing and writing skills, UGC Policy for Academic Integrity and prevention, Some Plagiarism detection tools

## Unit II

**Research and Publication ethics:** Scientific misconducts- Falsifications, Fabrication and Plagiarism (FPP), Publication ethics- definition, introduction and importance, Best practices/standard setting initiatives and guidelines-COPE, WAME etc., Violation of publication ethics, authorship and contributor-ship, Identification of publications misconduct, complains and appeals, Conflicts of Interest, Predatory publisher and journals.

**Mapping of Paper No. MSc/Chem/3/CC13**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | M | S | W | M | S | S | S | S |
| **CO2** | S | M | S | S | M | S | W | S | S | M | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. MacIntyre A: A short History of Ethics, London (1967).
2. Chaddah P: Ethics in Competitive Research: Do not get scooped; do not get plagiarized. ISBN: 978-9387480865(2018).
3. National Academy of Sciences, National Academy of Engineering and Institute of Medicine; On being a Scientist: A guide to Responsible Conduct in research: Third Edition. National Academics press (2009).

4. Resnik D. B.: What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10(2011).
5. Beall J: Predatory publishers are corrupting open access, Nature, 489 (7415), 179(2012).
6. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance ISBN: 978-81-939482-1-7(2019).
7. UGC regulations for Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutes (2018).
8. Ulrike kestler, Academic Integrity, Kwantlen Polytechnic University.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/CC14**
**Spectroscopy**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 Describes the basic concept of microwave spectroscopy and able to interpret the rotational spectra of rigid diatomic and polyatomic linear molecules and symmetric top molecules.
CO2 Explains the principle of Vibrational spectroscopy and able to solve numerical problems.
CO3 Know about NQR and ESR spectroscopy and illustrate their applications in chemistry.
CO4 Discuss the Raman spectroscopy and its application in physical chemistry.
CO5 Explains the principle of AAS and calculate percentage of alkali and alkaline earth metals.
CO6 Understand the basic concept of reciprocal lattice related to X-ray crystallography and interpretation of powder X-ray diffraction patterns.
CO7 Able to determine interplanar spacing for different crystal systems and structure factors for different types of lattices.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT I

**Rotational (microwave) Spectroscopy**
Rotational energies of linear molecules, Energy level populations, Merits and demerits of microwave spectroscopy, Rotational spectra of rigid linear molecules, non-rigid rotators. Determination of moment of inertia and bond length from rotational spectra, Relative intensities of spectral lines. Rotational spectra of non-linear molecules (brief mention).

**Vibrational Spectroscopy**
Harmonic and anharmonic Oscillators, Hooks law, vibrational energies of diatomic molecules, Absorption of radiations by molecular vibration. Vibrational energy levels, Selection rules, force constant, hot bands, Fundamental vibrational frequencies, Sampling techniques, Finger-print regions. Vibrations in polyatomic molecules.

## UNIT-II

**Nuclear Quadrupole Resonance Spectroscopy**
Introduction, energies of quadrupole transitions, effect of magnetic field on the spectra, relationship between electric field gradient and molecular structure, applications, interpretations of structural information from NQR spectra.

**Electron Spin Resonance Spectroscopy**
Features of ESR spectra, Measurement technique, Hyperfine coupling in isotropic system, Anisotropic splitting.

Electron-electron interaction, g-value and factors affecting g-value in transition metal complexes, Zero-field splitting, Kramer's degeneracy, Spin hamilton, Linewidth in ESR. Application to p-benzoisoquinone, DPPH and pyrazine.

## UNIT-III

**Raman Spectroscopy**

Polarization of light, Theories of Raman Effect, merits and demerits of Raman Spectroscopy. Pure rotational Raman spectra of linear molecules, Vibrational Raman spectra, selection rules, Rule of mutual exclusion. Factors affecting absorption frequencies. Interpretation and finger printing regions, Applications of Raman Spectroscopy.

**Atomic Absorption Spectroscopy**

General principles, resonance line, its natural width, Doppler effect, broadening due to pressure, Hollow cathode lamp. Application to alkali and alkaline earth metals.

## UNIT-IV

**X-Rays Crystallography**

Use of X-ray diffraction to find atomic arrangements. Point groups, Space groups and unit cell. Concept of reciprocal lattice. Braggs law in reciprocal space. Combining waves to obtain an image, Elementary treatment of structure factor and fourier synthesis. Anomalous scattering and its effect.

Representation of structural results, Chirality and absolute structure, Packing in crystals, Thermal and photochemical reactions in solids state.

**Mapping of Paper No. MSc/Chem/3/CC14**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO2** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO3** | M | M | M | S | W | S | S | W | S | S | S | S |
| **CO4** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO5** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO7** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings**


1. Organic Spectroscopy, W. Kemp, ELBS, London.
2. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming.
3. Spectrometric Identification of Organic compounds, R. M. Silverstein and G. C. Bassler.
4. Molecular Spectroscopy, H. S. Randhawa.
5. Structural Methods in Inorganic Chemistry, E. A. V. Ebsworth, D. W. H. Rankin, S. Cradock.
6. Physical Methods in Chemistry, R. S Drago.
7. Fundamentals of Molecular Spectroscopy, C. N. Banwell.
8. Atomic Absorption Spectrometry, Bernhard Welz, Michael Sperling.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC1-I**
**Inorganic Chemistry Special-I**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Explain basic concepts of photochemistry viz photochemical laws, quantum yield, electronically excited states, lifetime –measurements.
CO2 Describes the Energy dissipation by radiative and non-radiative processes along with Franck Condon principle, photochemical kinetics.
CO3 Demonstrates chemiluminescence and electronically excited states of metal complexes.
CO4 Give details about Metal complex sensitizer and explains photosensitized reactions in metal complexes.
CO5 Elaborate photo substitution, photoreduction etc.
CO6 Discuss the Kinetics and draw mechanism of coordination reactions in non-aqueous media.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT I

**Photo Inorganic Chemistry**

Basis of Photochemistry: Absorption, Excitation, Photochemical laws, Quantum yield, electronically excited states, lifetime measurements. Flash photolysis, Stop flow techniques. Energy dissipation by radiative and non-radiative processes, Absorption spectra, Franck Condon principle, Photochemical stages: Primary and Secondary processes.

## UNIT-II

**Excited States of Metal Complexes**

Excited states, Photochemical kinetics, Calculations of rates of radiative processes. Bimolecular deactivation: quenching. Electronically excited state of metal complexes, Comparison with organic compounds, Charge transfer spectra.

## UNIT-III

**Ligand Field Photochemistry**

Photo substitution, Photo-oxidation, Photo-reduction, Lability, and selectivity. Metal complex sensitizers (photosensitised reactions in metal complexes, water photolysis, carbon dioxide reduction). Chemical energy into light (chemiluminescence), Redox behaviour of Ruthenium. Excimer and Exciplex formation.

## UNIT-IV

**Non aqueous Solvents**

Basic Introduction, role of solvents in chemical reactions, Physical properties of a solvent, types of solvents and their general characteristics. Kinetics and mechanism of coordination reactions in

non-aqueous media, Electrode potential and its relation to spontaneity and application in the prediction of chemical reactions, Reaction in non-aqueous media with reference to $H_2SO_4$, $BrF_3$, $CH_3COOH$, HCN and $N_2O_4$. Reactions in molten salts.

**Mapping of Paper No. MSc/Chem/3/DSC1-I**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO2** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO3** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO4** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO5** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO6** | S | S | S | W | M | M | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings**


1. Concepts of Inorganic Photochemistry, A. W. Adamson, P. D. Fleischauer.
2. Photochemistry of Coordination Compounds, V. Balzani, V. Carassiti.
3. Elements of Inorganic Photochemistry, G. J. Ferraudi.
4. Inorganic Chemistry, J. E. Huheey, 3rd Edition.
5. Selected Topics in Inorganic Chemistry, W. U. Malik, G. D. Tuli, R. D. Madan.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC2-I**
**Inorganic Chemistry Special-II**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Describe Silicates, minerals, and its types in detail.
CO2 Discuss and draw structures and properties of Oxoacids of Nitrogen, Phosphorus, and sulphur.
CO3 Explains Metal Carbides & Xenon compounds - its types, Structure, preparation, and properties of.
CO4 Give details about the preparation, properties and characterisation of hydride complexes.
CO5 Explain different complexes of lanthanides and actinides with focus on spectral & magnetic properties.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Main group elements**

Silicates minerals and its types, Silicones, Zeolites,
Oxoacids of Nitrogen, Phosphorus and Sulphur: structure, preparation and properties, Oxides of Nitrogen, Phosphorus and sulphur: structure, preparation and properties, Metal Carbides and its types: Structure, preparation and properties of Xenon compounds.

## UNIT-II

**Transition Metal Compounds with bonds to Hydrogen**

Characterization of hydride complexes, Synthetic methods, Chemical behaviour of hydride compounds, Mononuclear poly-hydrides, Homoleptic polyhydrides anions, Carbonyl hydrides and hydride anions. Molecular hydrogen compounds. M–H interactions, Synthetic applications of metal hydrides, Monohydrido compounds.

## UNIT-III

**Chemistry of Lanthanides**

Electronic structure, Oxidation state and ionic radii, magnetic properties, colour and spectra Lanthanide contraction and its consequences, Extraction of Lanthanoids, Binary and Ternary compounds, Oxo salts (Not special focus on individual elements), Cyclopentadienyl compounds (Not special focus on individual elements), Use of lanthanides as shift reagents.

## UNIT-IV

**Chemistry of Actinides**

Electronic structure, Oxidation state and ionic radii, magnetic properties, colour and spectra of Actinoids, Actinide contraction. Chemistry of actinium, thorium, protactinium, uranium,

Similarities between later actinides and lanthanides. Differences between actinides and lanthanides. Trans-uranic elements, Cyclopentadienyl compounds (Not special focus on individual elements).

**Mapping of Paper No. MSc/Chem/3/DSC2-I**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO2** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | M | M | M | S | W | S | S | W | S | S | S | S |
| **CO5** | S | S | M | S | M | M | S | S | S | S | S | M |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings**


1. Selected Topics in Inorganic Chemistry, W. U. Malik, G. D. Tuli, R. D. Madan.
2. Inorganic Chemistry, J. E. Huheey, 3rd edition.
3. Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson 5th Edition.
4. Principles of Organometallic Chemistry, G. F. Coates, M. L. H. Green, P. Powel and K. Wade.
5. Inorganic Chemistry, K. P. Purcell, J. V. Kotz.
6. Chemistry of Elements, N. N. Greenwood, A. Earnshaw.
7. Inorganic Chemistry, K. P. Purcell, J.V. Kotz.
8. Chemistry of Elements, N. N. Greenwood, A. Earnshaw.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC3-I**
**Inorganic Chemistry Special-III**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Explain various rings, cages and chains.
CO2 Describe the concept and language of supramolecular Chemistry.
CO3 Demonstrate the various supramolecules and their role in catalysis.
CO4 Give details about Metal Storage, their Transportations in living organisms and Biomineralization.
CO5 Discuss the role of iron in biological systems.
CO6 Elucidate the structural characteristics and role of vitamin $B_{12}$ in living systems.
CO7 Describes the types of zinc containing metalloenzymes, their structure and mechanistic approach in involving various reactions occurring in living organisms.
CO8 Able to draw the structure and role of copper and molybdenum enzymes in biological systems.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

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## UNIT I

**Inorganic Chains, Rings and Cages**

Chains: Catenation, Intercalation chemistry, Isopolyanions and Heteropolyanions.
Rings: Borazines, phosphazenes and other heterocyclic inorganic ring systems, homocyclic inorganic systems.
Cages: Oxides and sulphides of phosphorus, Arsenic sulphides

## UNIT II

**Supramolecular Chemistry: Concepts and language**

Molecular recognition: Design Principles, Recognition of Tetrahedral and Ammonium Ions and Related Substrates, design and synthesis of co-receptor molecules and multiple recognition. Supramolecular reactivity and catalysis. Transport processes and carrier design. Supramolecular devices. Some examples of self-assembly in supramolecular Chemistry.

## UNIT-III

**Bioinorganic Chemistry-I**

Energy sources for life, Metalloporphyrin's, Photosynthesis and respiration, Chlorophyll: Structure, function and synthetic model, Cytochromes: Structure and function, CN and CO poisoning. Ferredoxins and Rubredoxin, Bio-redox agents and mechanisms, Hemoglobin and myoglobin: Structure and mechanism of function, Cooperativity. Vitamin $B_{12}$, Enzymes, Coenzymes: Structure and functions, Synthetic model of enzyme action, Inhibition and poisoning by ligands and metal ions, Xanthine oxidase, carbonic anhydrase, carboxypeptidase, superoxide dismutase, Nitrogen fixation.

## UNIT-IV

**Bioinorganic Chemistry-II**

Biochemistry of Iron: Availability of iron, competition for iron, iron toxicity and nutrition. Essential and trace elements in biological systems, Periodic survey of essential and trace elements, biological importance and relative abundance. Biochemistry of the non-metals: Structural uses. Antibiotics and related compounds, Chelate therapy. Problems in biological systems, Agriculture, Gaseous air pollution, Acid rain, Nitrogen oxides, Chlorofluorocarbons and upper atmosphere, Particulate pollution, mixing problems.

**Mapping of Paper No. MSc/Chem/3/DSC3-I**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO2** | M | M | S | M | S | S | M | M | S | S | M | M |
| **CO3** | S | S | S | M | S | M | S | S | S | M | M | M |
| **CO4** | S | M | S | S | S | S | M | S | S | S | S | M |
| **CO5** | M | S | S | M | S | M | S | S | M | M | S | M |
| **CO6** | S | S | M | S | M | M | S | S | S | S | S | S |
| **CO7** | M | S | S | S | S | M | S | S | S | S | M | M |
| **CO8** | S | S | M | S | M | M | S | S | S | S | S | M |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings**


1. Inorganic Chemistry: A Unified Approach, W.W. Porterfield.
2. Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson 5th Edition.
3. Inorganic Chemistry, 3rd edition J. E. Huheey.
4. Supramolecular Chemistry, J.M. Lehn, VCH.
5. Bioinorganic Chemistry, Ivano Bertini, Harry B. Gray, Stephen J. Lippard.
6. Chemistry of Elements, N. N. Greenwood, A. Earnshaw.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC4-I**
**Inorganic Chemistry Special Practical-I**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**
CO1 Discuss the basic concept about the qualitative analysis.
CO2 Analyse the given mixture for the presence of one acidic radical, two rare earth metal ions and one insoluble salt.
CO3 Prepare a sample of various coordination complexes.
CO4 Prepare mentally to face viva-voce.

**Syllabus -**

1. **Qualitative analysis:**
   Total four radicals to be given containing two less common metal ions, one insoluble and one acid radicals:
   a) Less common metal ions: Tl, Mo, W, Ti, Zr, Th, V, U (two metal ions in cationic/anionic forms)
   b) Insoluble oxides ($Al_2O_3$, $Cr_2O_3$, $SnO_2$, $TiO_2$, $SiO_2$), Sulphates ($PbSO_4$, $BaSO_4$) and Halides (AgCl, AgBr, AgI)
   c) Acid radicals: $CO_3^{2-}$, $HCO^{3-}$, $CH_3COO^-$, $PO_4^{3-}$, $C_2O_4^{2-}$, $NO_2^-$, $NO_3^-$, $Cl^-$, $Br^{1-}$, $I^-$, $S^{2-}$, $SO_3^{2-}$, $SO_4^{2-}$, $S_2O_3^{2-}$.
2. **Preparations of Complexes**
   a) Preparations of tetraminezinc(II) flouroborate $[Zn(NH_3)_4][BF_4]_2$
   b) Preparations of dinitrotetraminenickel(II) $[Ni(NH_3)_4\ (NO_2)_{\ 2}]$
   c) Preparations of hexaimnenickel(II) chloride $[Ni(NH_3)_6\ ]Cl_2$
   d) Preparations of nitropentaminechromium(III) chloride $[Cr(NH_3)_5(NO_2)]Cl_2$
   e) Bis-(tetraethylammonium) tetrachlorocuprate (II)
   f) Preparations of bis-(ethylenediamine)copper(II) diiodocuprate (I)
   $[Cu\{C_2H_4(NH_2)_2\}_2]\ [CuI_2]_2$

**Note:** Demonstration of different software useful in Chemistry for drawing the structure of compounds.
Draw the Scheme used for the preparation using any structural drawing tool.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**
**Mapping of Paper No. MSc/Chem/3/DSC4-I**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | M | S | M | M | M | S | S | S | M | S |
| CO2 | S | M | S | M | S | S | M | M | S | M | S | M |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Vogel's Textbook of Quantitative Analysis, revised edition, J. Bassett, R. C. Denney, G. H. Jeffery, J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly.
3. Inorganic Synthesis, Vol. 5 & 9, McGraw Hill.
4. Practical Inorganic Chemistry, G. Marr, B. W. Rockett.
5. Experimental inorganic, physical chemistry, M. A. Malati, Woodhead Publishing (1999).

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC1-P**
**Physical Chemistry Special-I**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Describe types of ensembles.
CO2 Discuss corresponding distribution laws.
CO3 Explain Maxwell-Boltzmann statistics and discuss Maxwell distribution law of velocities.
CO4 Describe Bose-Einstein and Fermi-Dirac statistics and their comparison.
CO5 Know about partition function and its factorization.
CO6 Discuss translational thermodynamic function.
CO7 Explain rotational and vibrational partition functions and evaluate thermodynamics properties.
CO8 Know the Concept of electrical double layer and its structure.
CO9 Know about Helmholtz-Perrin, Gouy-Chapman, and Stern models, electrokinetic phenomena, and the determination of zeta potential.
CO10 Discuss the Contact adsorption on the electrode and its water Flip-Flop model.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Statistical Mechanics**

Concept of distribution, Thermodynamic probability and most probable distribution, Canonical, grand canonical and micro canonical ensembles. Maxwell-Boltzmann statistics, Boltzmann distribution, Derivation of the Boltzmann distribution expression, Determination of the Boltzmann constant, Maxwell distribution law of velocity from Boltzmann distribution expression, The Bose-Einstein statics, Statistics of a photon gas, Fermi-Dirac statistics, and comparison of three statistics.

## UNIT-II

**Statistical Thermodynamics**

Partition function and thermodynamic properties, Factorization of partition function, Relationship of atomic and molar partition function to thermodynamic properties, Translational partition function, Calculation of absolute entropy of an ideal monoatomic gas, Seckure-Tetrode equation. Diatomic molecules, Separation of internal partition function. Vibrational and rotational partition function of diatomic molecules. Calculation of contribution of vibrational, rotational partition functions towards various thermodynamic properties. Electronic partition function, Effect of change of zero-point energy on partition function. Chemical equilibrium and equilibrium constant in terms of partition functions.

## UNIT-III

**Electrochemistry-I**

Electrified Interfaces: Thermodynamics of electrified interfaces, Electrocapillary thermodynamics, non-polarizable interface, and Thermodynamic equilibrium. Fundamental thermodynamic equation of polarizable interfaces. Determination of excess charge density on the

electrode, electrical capacitance and surface excess of the interface, potential of zero charge, Helmholtz-Perrin model, Gouy-Chapman model, and Stern model.

## UNIT-IV

**Electrochemistry-II**

Contact adsorption on the electrode, Free energy of contact adsorption, The degree of contact adsorption and the measurement of contact adsorption, The influence of the contact adsorption on the capacity of the interface, Capacity-potential curve, The position of the OHP and the constant capacity, The capacitance hump, Variation of the population of contact-adsorbed ions with electrode charge, The lateral-repulsion model and the water Flip-Flop model of contact adsorption, The contribution of adsorbed water dipoles to the capacity of the interface.

**Mapping of Paper No. MSc/Chem/3/DSC1-P**

| Course Outcome | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO2 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO3 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO4 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO5 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO6 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO7 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO8 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO9 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO10 | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. An Introduction to Chemical Thermodynamics, R. P. Rastogi, R. R. Mishra.
2. Introduction to Statistical Thermodaynamics, M. Dole.
3. Chemical Physics, J. C. Slater.
4. Theoretical Chemistry, S. Glasstone.
5. Modern Electrochemistry, J. O. M Bockris, A. K. N Reddy, Plenum Publishing Corp.
6. An Introduction to Electrochemistry, S. Glasstone.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC2-P**
**Physical Chemistry Special-II**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Discuss about the various defects present in solids and to discuss about the Metals, insulators and semiconductors.
CO2 Procedure of scientific development/understanding through various theories proposed to explain the properties of solids.
CO3 Know about Bloch theorem, Brillouin zones, effective mass of charge carriers, hole concept.
CO4 Classify semiconductors as direct and indirect band gap materials.
CO5 Discuss free carrier concentration in different types of semiconductors and effect of temperature on electrical conductivity of semiconductors.
CO6 Discuss the Variation and Perturbation theorem.
CO7 Discuss VB and MO treatments and extension od MO theory to homonuclear and heteroatoms.
CO8 Discuss Huckel theory of conjugated systems and apply it to various organic molecules.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Solid State-I**

Perfect and imperfect crystals, intrinsic and extrinsic defects, point defects, line and plane defects, vacancies- schottky defects and Frankel defects, colour centers, non-stiochiometry and defects.

Classification of solids, Lattice energy, Evaluation of Madelung constant (NaCl), Calculation of repulsive potential exponent: Lattice heat capacity. Einstein and Debye model of lattice heat capacity, Debye $T^3$ law.

## UNIT-II

**Solid State-II**

Free electron theory of metals, Quantum mechanical treatment explaining the origin of band gaps, density of states, Band theory, Bloch theorem, Brillouin zones, effective mass of charge carriers, Semiconductors: Direct and indirect band gap semiconductors, hole concept, temperature dependence of mobility and electrical conductivity, free carrier concentration in intrinsic and extrinsic semiconductors, mass active law, Generation of carriers and their recombination in semiconductors. Types of junctions (metal-semiconductor, semiconductor-semiconductor, junctions in organic materials).

## UNIT-III

**Quantum Mechanics-I**

Problem of two electrons, exchange interactions. Approximate methods: First order time-independent perturbation theory for non-degenerate states. Variation theorem and variational

methods. Ground and excited state of helium atom. Coupling of angular momentum for many electron system, spin-orbit coupling, Molecular Term symbols. Born-Oppenheimer approximation, the hydrogen molecule ion, the hydrogen molecule, their symmetric and antisymmetric solution (without actual evaluation of various integrals).

**Unit-IV**

**Quantum Mechanics-II**

Valence bond and MO (LCAO) treatment of hydrogen molecule. Comparison of the MO and VB treatments and their equivalence limit. Configuration Interaction. Extension of MO theory to other systems- Homonuclear and heteronuclear diatomics, simple polyatomic molecules.

The pi-electron approximation, Huckel theory of conjugated systems. Applications to ethylene, butadiene, cyclobutadiene and cyclopropenyl molecules. Calculation of properties- Delocalization energy, electron density, bond order.

**Mapping of Paper No. MSc/Chem/3/DSC2-P**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | W | S | M | S | - | - | S | S | S | S |
| **CO2** | S | S | S | S | M | S | - | - | S | S | S | S |
| **CO3** | S | S | S | S | M | S | - | - | S | S | S | S |
| **CO4** | S | S | S | S | M | S | - | - | S | S | S | S |
| **CO5** | S | S | S | S | M | S | - | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | - | M | S | S | S | S |
| **CO7** | S | S | S | S | M | S | - | M | S | S | S | S |
| **CO8** | S | S | S | S | M | S | - | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Principles of the Solid State, H.V. Keer, Wiley Eastern.
2. Solid State Chemistry and its Applications, A. R.West, Plenum
3. Solid State Chemistry, N. B. Hannay.
4. Solid State Chemistry, D. K. Chakrabarty, New age International.
5. Solid State Chemistry, W. E. Garner.
6. Physical Chemistry, Puri, Sharma and Pathania.
7. Quantum Chemistry, I. M. Levine, Prentice-Hall.
8. Introduction to Quantum Chemistry, A. K.Chandra, Tata Mc Graw Hill.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC3-P**
**Physical Chemistry Special-III**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Explain the basic concepts of polymers and polymerization.
CO2 Discuss the Mechanism and Kinetics of chain growth and step growth polymerization.
CO3 Discuss applications of biodegradable polymers and Glass Transition temperature and its factors.
CO4 Determine the molecular mass by osmometry and ultracentrifugation methods.
CO5 Discuss the thermal analytical techniques like TGA, DTA, DSC and importance of commercial polymers.
CO6 Describe thermodynamic properties of mixing.
CO7 Know about thermodynamic relations for dilute polymer solutions.
CO8 Know the concept of nephelometry and turbidimetry and its use in the quantitative inorganic analysis.
CO9 Determining the percentage of optically active substance in a mixtures and finding out the relative strength of acids.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Polymer Chemistry**

Classification of polymers, Polymerization: Condensation, Addition, Radical chain, Ionic, Coordination and Co-polymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems. Kinetics of polymerization. Polydispersion-average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution.

Applications of biodegradable polymers, Hyperbranched–star polymers, Dendrimers, Plasticizers, Polymer composites.

Glass transition temperature (Tg), factors influencing the glass transition temperature, effect of molecular weight and melting point on glass transition temperature, importance of glass transition temperature.

## UNIT-II

**Polymer Characterization**

The practical significance of molecular weight. Measurement of molecular weights: End group, Osmotic and Ultracentrifugation methods. Analysis and testing of polymers: Chemical analysis of polymers, Spectroscopic methods and Microscopy. Thermal analysis (TGA, DTA, DSC) and physical testing: Tensile strength, Fatigue, Impact, Tear resistance and Hardness & Abrasion resistance.

**Commercial Polymers**

Polyethylene, Polyvinyl chloride, Polyamides, Polyesters, Phenolic resins, Epoxy resins and Silicone polymers. Functional polymers: Fire retarding polymers and electrically conducting polymers.

## UNIT-III

**Thermodynamics of Polymer Solutions**

Radius of gyration of polymer chains, statistical distribution of end-to-end dimensions, freely jointed chain in three dimensions, influence of bond angle restrictions.

Entropy of mixing and enthalpy of mixing by lattice model, Flory Huggins lattice theory, limitations of lattice model, entropy of mixing by free volume theory, heat and free energy of mixing, partial molar quantities i.e., chemical potential, heat of dilution and partial molar entropy of mixing, excluded volume, thermodynamic relations for dilute polymer solutions.

## UNIT-IV

**Turbidimetry, Refractometry and Polarimetry**

Nephelometry and Turbidimetry, Theory of Nephelometry and Turbidimetry, Instruments, Applications of scattering methods, Refractometry, Measurement of refractive index. Specific and molar refraction, Variables that affect refractive index measurements, Instruments for measuring refractive index, Applications of refractometry, Polarimetry, optically active compounds, Variables that affect optical rotation, Mechanism of optical rotation, Polarimeters, Applications of optical polarimetry.

**Mapping of Paper No. MSc/Chem/3/DSC3-P**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO2** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | M | S | M | S | W | M | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO7** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO8** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO9** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1.Polymer Chemistry, Billmayer.
2. Polymer Chemistry, Gowarikar.
3. Principles of Polymerization, Geroge Odian.
4. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
5. Fundamental of polymer Science; Springer.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC4-P**
**Physical Chemistry Special Practical-I**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Understand and master the fundamentals of conductometric titrations in aqueous media.

CO2 Apply pH-metry in-

- Determining buffer solutions and determining their pH values.
- Performing acid-base titrations.
- Determining degree of hydrolysis and dissociation constants.

CO3 Apply the technique of spectrophotometry for:

- Verifying Lambert-Beer's law.
- Determining composition of various mixtures.

CO4 Apply the technique of polarimetry for:

- Determining the percentage of optically active substance in a mixture.
- Finding out the relative strength of acids.
- Studying the effect of substituents on rate constant of inversion kinetics.

**Syllabus -**

**Conductometry**

1. Determination of the equivalent conductance of strong electrolytes such as HCl, KCl, $KNO_3$, $AgNO_3$ and NaCl and the validity of Onsager equation.
2. Determination of the solubility of lead sulphate and silver halides.
3. Conductometric titration of Strong acid *vs*. strong base using conductivity meter.
4. Conductometric titration of weak acid *vs*. strong base using conductivity meter.
5. Conductometric titration of Strong acid *vs*. weak base using conductivity meter.
6. Conductometric titration of weak acid *vs*. weak base using conductivity meter.

**pH Metry**

1. Acid base titration of a non-aqueous media using pH meter.
2. Determination of dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.

**Colorimetry/Spectrophotometry**

1. Determine the concentration of Crystal violet and Aurine in mixture of (Crystal violet + Aurine) solution.
2. To determine the absorption maxima of a compound using a UV-Visible spectrophotometer.
3. To determine the dissociation constant (Ka) of Methyl red using absorption spectrophotometer.
4. Verification of Lambert's-Beer law using solutions such as $I_2$ in $CCl_4$, and $K_2Cr_2O_7$, $CuSO_4$ and $KMnO_4$ in water.

**Polarimetery**

1. To determine the concentration of an optically active substance.
2. To determine the percentage of two optically active substances in a given mixture.

**Solution Chemistry**

1. Determination of Solubility by evaporation method.
2. Determination of Solubility by gravimetric method.
3. Determination of transition temperature by thermometric method.

**Data-Handling/Representation**

Using origin-Lab draw/ EXCEL data in different styles of graphs.

**Experiment & Written part** **Marks: 70**

**Lab record** **Marks: 10**

**Viva-voce** **Marks: 20**

**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/3/DSC4-P**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | M | M | S | S | S | S |
| **CO2** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Practical Chemistry, A. M. James, F. E. Pricherd, Longman.
2. Practical Physical Chemistry, B. P. Levitt and Findley's, Longman.
3. Practical Physical Chemistry, S. R. Palit, S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R. C. Das, B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC1-O**
**Organic Chemistry Special-I**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Demonstrate the principle of oxidation, oxidative processes related to Hydrocarbons- alkenes, aromatic rings, activated and unactivated saturated C-H groups, alcohols, diols, aldehydes, ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides

CO2 Describe the applications of ruthenium tetraoxide and thallium (III) nitrate in oxidation of various types of compounds.

CO3 Describe the general pathways of reduction reactions. Reduction of Hydrocarbons – alkanes, alkenes, alkynes, substituted and unsubstituted aromatic rings.

CO4 Understand & apply the reduction of carbonyl compounds – aldehydes, ketones, acids and their derivatives, Epoxides. Reduction of compounds containing nitro, nitroso, azo and oxime groups.

CO5 Describe the principle of Organometallic Reagents and their applications in organic synthesis.

CO6 Illustrate the role of various Organometallic Reagents of Li, Mg, Cd, Zn, Cu, S, Si, B, Sn I, Pd, Co, Cr and Ti compounds in organic synthesis along with their preparations, properties and applications of these reagents with mechanistic details.

CO7 Discuss about the preparation & applications of DCC, LDA, DDQ, NBS.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT – I

**Oxidation**

Introduction to Different oxidative processes: Hydrocarbons- Alkenes, aromatic rings, saturated C-H groups (activated and unactivated), alcohols, Diols, Aldehydes, Ketones, Carboxylic acids, amines, hydrazines and sulfides.

Oxidation with ruthenium tetraoxide, Iodobenzene diacetate and thallium (III) nitrate.

## UNIT – II

**Reduction**

Hydrogenolysis, Hydrogenation. Introduction to Different reductive processes: Hydrocarbons- Alkenes, alkynes and aromatic rings, Carbonyl compounds: aldehydes, ketones, acids and their derivatives. Epoxides, nitro, nitroso, azo and oxime groups.

## UNIT – III

**Organometallic Reagents I**

Principle, preparations, properties and applications of the reagents of the following metals/non-metals in organic synthesis with mechanistic details:

Organolithium, Organomagnesium, Organocadmium, lithiumcuprates, Organozinc, Organosulphur, Organosilicon, organoboranes and Organoiodides (III).

## UNIT - IV

**Organometallic Reagents II**

Principle, preparations, properties and applications of the reagents of the following metals in organic synthesis with mechanistic details:

Organotin, Organopalladium (Heck, Stille, Suzuki, Negishi and Sonogashira), Organocobalt, Organo chromium compounds and Organo titanium (Tebbe olefination).

**General Reagents**: Principle, preparation, properties and applications of the following in organic synthesis with mechanistic details: DCC, LDA, DDQ, NBS.

**Mapping of Paper No. MSc/Chem/3/DSC1-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | M | M | S | S | S | S | S |
| **CO2** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO6** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO7** | S | S | S | S | S | S | M | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press
2. Modern Synthetic Reactions, H. O. House, W. A, Benzamin
3. Advanced Organic Chemistry, Part B., F. A. Carey, R. J. Sundberg
4. Principles of Organic Synthesis, R. O. C. Normon, J. M. Coxon
5. Some Modern Method of Organic Synthesis, W. Carruther, Cambridge Univ. Press.
6. Advanced Organic Chemistry, Reactions Mechanism and Structure, J. March, John Wiley.
7. Advanced Organic Chemistry and Reaction Mechanisms, Reinhard Bruckner, Academic Press.
8. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC2-O**
**Organic Chemistry Special-II**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Appreciate the role of Molecular Orbitals in analyzing Pericyclic Reactions.
CO2 Interpret the stereochemical course of a Pericyclic Reaction – Electrocyclic, cycloaddition and sigmatropic reactions and identify the product.
CO3 Predict the course of an organic photochemical reaction and identify the product with the type of functional group present on the molecule.
CO4 Predict the course of photochemical reaction - Photolysis of hypohalites, Barton reaction, Hoffman-Loefller-Freytag reaction, Di-π methane rearrangement, Photodegradation of polymers.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT – I

**Pericyclic Reactions-I**

Molecular orbital symmetry, Frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagram method, FMO and PMO approach.

**Electrocylic reaction:** conrotatory and disrotatory motions. 4n, 4n +2, allyl systems.

**Cycloadditions:** antarafacial and suparafacial additions, 4n and 4n+2 systems, Stereochemistry of Cycloaddition Reactions with focus on Endo/Exo stereoselectivity, stereochemistry of products due to stereochemistry of diene, Orientation effects in Diels Alder reaction, 2+2 addition of ketenes, 1,3-Dipolar cycloadditions and Cheliotropic reactions.

## UNIT – II

**Pericyclic Reactions-II**

**Sigmatropic rearrangements:** suprafacial and antarafacial shifts of H & Sigmatropic shifts involving carbon moieties with special focus on 1,3 & 1,5 moieties. Retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements, Detailed treatment of Sommelet-Hauser, Claisen and Cope rearrangements.

Introduction to Ene reactions. Simple problems on pericyclic reactions. Group transfers and eliminations.

## UNIT – III

**Photochemistry-I**

**Photochemical Reactions:** Excitation & Excited states, types of excitations, Franck-Condon Principle, Jablonski diagram, Energy transfer Photsensitization, Quenching, Quantum efficiency and quantum yield.

**Photochemistry of Carbonyl Compounds:**
Photochemistry of carbonyl compounds (Norrish type I and type II changes, photoreaction of cyclic ketones, Paterno-Buchi reaction and Photoreduction, Photochemistry of olefins and 1, 3-Butadiene (cis-trans isomerization, dimerization and cycloadditions).

**UNIT – IV**

**Photochemistry-II**

**Photochemistry of Aromatic Compounds:** Isomerisations, cyclization, additions and substitutions reactions.

**Miscellaneous Photochemical Reactions:** Photolysis of hypohalites, Barton reaction, Hoffman-Loefller-Freytag reaction, Di-π methane rearrangement, Photodegradation of polymers.

**Mapping of Paper No. MSc/Chem/3/DSC2-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | M | M | S | S | S | S |
| **CO2** | S | S | S | S | S | S | M | M | S | S | S | S |
| **CO3** | S | S | S | S | S | S | M | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | M | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Organic photochemistry, J. Coxan, B. Halton, Cambridge University Press.
2. Introductory Photochemistry, A. Cox, T. Camp Mc Graw Hill.
3. Organic Reactions and Orbital Symmetry, T. L Gilchrist, R. C. Storr, Cambridge University Press. Cambridge, 2nd Ed. 1979.
4. Organic photochemistry, Chapman and Depuy.
5. Organic Photochemistry, W. H. Horspool.
6. Photochemistry of excited states, J. D. Coyle.
7. Pericyclic Reactions, S. M. Mukherji.
8. Aspects of Organic Photochemistry by Horspool, W. M.
9. Pericyclic Reactions by Marchand, A. P. & Lehr, R. E.
10. Organic Photochemistry and Pericyclic Reactions, M G Arora.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC3-O**
**Organic Chemistry Special-III**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Understand, define and classify terpenoids, isoprene and special isoprene rule, general methods of structure elucidation of terpenoids.

CO2 Apply the acquainted knowledge for structure elucidation and synthesis of Geraniol, α-terpineol, α-pinene, camphor, farnesol, citral, α-carotene, β-carotene and γ-carotene and biosynthesis of terpenoids.

CO3 Illustrate steroids and their classification, Isolation and nomenclature, structure elucidation, synthesis and stereochemistry of cholesterol.

CO4 Describe synthetic pathways of testosterone, progesterone, 5α- and 5β-cholanic acids from Cholesterol. Johnson's hydrochrysene approach for the synthesis of androsterone.

CO5 Appreciate general aspects of isolation and structure elucidation of alkaloids for application in structure elucidation, synthesis and biosynthesis of listed alkaloids.

CO6 Understand general aspects of isolation and degradative and synthetic aspects of structure elucidation of flavonoids.

CO7 Apply this knowledge for structure elucidation and synthesis of Cyanin, Quercetin, Diadzein and Chrysin.

CO8 Understand the biosynthetic Acetate and Shikimic acid pathway leading to production of Flavonoids.

CO9 Describe about the nomenclature and biological roles of prostaglandins, synthesis $PGE_2$ and $PGF_{2\alpha}$.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Terpenoids**

General aspects of structure determination of terpenoids, isoprene rule & special isoprene rule.
Structure elucidation and synthesis of Geraniol, α-terpineol, α-pinene, camphor, farnesol and citral. Biosynthesis of terpenoids.

**Carotenoids**

Structure elucidation and synthesis of α-carotene, β-carotene and γ-carotene.

## UNIT – II

**Steroids**

Isolation and nomenclature of steroids. Structure elucidation, Woodward synthesis and stereochemistry of cholesterol.
Methods for the following conversions.

1. Cholesterol → Testosterone
2. Cholesterol → Progesterone
3. Cholesterol → 5-α and 5-β cholanic acids.

Johnson's hydrochrysene approach towards the synthesis of Androsterone.

## UNIT – III

**Alkaloids:** Definition, Classification (based on N-heterocyclic ring), Nomenclature and physiological action, occurrence, general methods of structure elucidation.
Structure, Stereochemistry, synthesis and biosynthesis of following: Nicotine, Quinine, morphine and Ephedrine and (+)- Coniine, role of alkaloids in plants.

## UNIT – IV

**Plant Pigments**: Occurance, nomenclature and methods of structure determination and synthesis of the following: Quercetin, Cyanine, Diadzein, Chrysin. Biosynthesis of Flavonoids.

**Prostaglandins**

General Introduction, nomenclature and biological roles of prostaglandins, Synthesis of $PGE_2$ and $PGF_{2\alpha}$.

**Mapping of Paper MSc/Chem/3/DSC3-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | W | S | S | S | S | S | S | S |
| **CO2** | S | S | S | S | W | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | W | S | M | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO6** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO7** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO8** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO9** | S | S | S | S | S | S | M | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Natural Products: Chemistry and Biological Significance, J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthrope, J. B. Harborne, Longman, Essex.
2. Organic Chemistry, Vol-2, I. L. Finar, ELBS.
3. New Trends in Natural Products Chemistry, A. Rahman, M. I. Choudhary, Harwood Academic Publishers.

**M.Sc. Chemistry (3rd Sem.)**
**MSc/Chem/3/DSC4-O**
**Organic Chemistry Special Practical-I**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO 1 Understand the concept of stepwise synthesis of a product and their purification.
CO 2 Explore various combinations of reactions that can be exploited to form a product.
CO 3 Able to understand the application of structural drawing tools such as Chem Axon, Chem Draw etc. for sketching the organic compounds, finding IUPAC nomenclature, $^{1}$H NMR prediction and some useful physical properties of small organic compounds.
CO 4 Perform experimentation and evaluate the results.
CO 5 Demonstrate the ability to compile interpreted information in the form of lab record.
CO 6 Prepares mentally to face viva-voce.

**Syllabus –**

**Preparations of Organic compounds involving two and three stages:**

1. Hydroquinone — Benzoquinone — 5- Hydroxy benzoxathiole-2-one
2. Acetophenone — Acetophenone oxime — Acetanilide
3. Benzaldehyde — Benzoin — Benzil — Benzillic acid
4. Nitrobenzene — m-dinitrobenzene — m-nitroaniline — m-nitrophenol
5. Phthalic acid — phthalic anhydride – phthalimide — Anthranilic acid
6. Phthallic anhydride – o-Benzoylbenzoic acid – Anthraquinone – Anthrone
7. Ethyl acetate – Ethylacetoacetate — 4-methyl-7-hydroxycoumarin — 6 and 8- nitro-4-methyl-7-hydroxycoumarin
8. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene
9. O - Chlorobenzoic acid —N-phenylanthranilic acid —acridone
10. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene
11. Chlorobenzene—2,4-dinitrochlorobenzene —2,4-dinitrophenol
12. Any other multi step reaction as per requirement

**Note:**

1. All the students must check the progress of reaction and purity of Final products for all the stages of preparation by either recrystallisation or Thin layer Chromatography.
2. Demonstration of different software useful in Chemistry for drawing the structure of Organic compounds as well as for the computational studies of small organic molecules.
3. Draw the Scheme used for a multi-step preparation (two or three) using any structural drawing tool & get the IUPAC name and predicted $^{1}$H-NMR spectrum for each compound involved in multi-step preparation.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/3/DSC4-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO2** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO3** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO4** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO6** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. "Elementary Practical Organic Chemistry by Arthur I. Vogel Longmans, Green and Co. 1958.
2. "An Introduction to Practical Biochemistry", by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. Practical Organic Chemistry' by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. "Experiments in Organic Chemistry" Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. "Organic Synthesis" Collective Vol. I.
7. “Laboratory Manual in Organic Chemistry' by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/SEC2**
**Applied Spectroscopy**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 Describes the basic concept of Ultraviolet and Visible Spectroscopy.
CO2 Elaborates the Beer-Lambert law, effect of solvent on electronic transitions & apply Fieser-Woodward rules for calculating $\lambda_{max}$ for conjugated dienes and carbonyl compounds.
CO3 Discuss the methods of fragmentation of organic compounds - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance.
CO4 Able to apply the concept of mass spectrometry for the determination of structure of organic compounds based on fragmentation.
CO5 Give details about principle of IR spectroscopy and various absorption bands and apply the knowledge in interpreting organic compounds.
CO6 Describes the basic concept behind NMR spectroscopy and its application for the structure elucidation.
CO7 Discuss the chemical shift and coupling constant of $^{1}$H-NMR in relation to stereochemical structure of the organic compound.
CO8 Explains the difference between First order & non-first order NMR spectra and Tools used for simplification of complex NMR spectrum (instrumental and chemical).
CO9 Give the details, chemical shifts of $^{13}$C-NMR and their applications in structure determination of organic compounds.
CO10 Demonstrate NOSY, COSY and NOE.
CO11 Able to solve the composite problems of IR, NMR, Mass and UV spectroscopy.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT I

### Ultraviolet and Visible Spectroscopy

The energy of electronic excitation, Measurement techniques, Beer-lambert law, Molar extinction coefficient. The Frank-Codon principle. Different types of transition in UV spectrum of organic functional groups and their relative energies, Chromophore, Auxochromes, Factors affecting extinction coefficient ($\lambda_{max}$). Effect of steric hindrance to coplanarity, Solvent effects. Absorption spectra of charge transfer complexes. Woodward Fieser rules for conjugated dienes and carbonyl compounds. Applications of UV-Vis spectroscopy.

### Mass Spectrometry

Elementary theory, Measurement techniques (EI, CI, FD, FAB), Resolution, Exact masses of nuclides, Molecular ions, Isotopic ions, Rearrangement of ions. Factors affecting cleavage, cleavage patterns, simple cleavage, cleavages at heteroatoms, Multicentre fragmentations rearrangements, Retro Diels-Alder fragmentations. Cleavage associated with common functional groups (aldehydes, ketones, acyclic esters, alcohols, olefins, aromatic amine compounds).

Special methods of GC-MS, High resolution MS, Interpretation of the spectrum of an unknown compound.

## UNIT-II

**Infrared Spectroscopy**

Principle and Theory, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines, nitriles and isonitriles. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FT-IR. Effects giving rise to absorption bands. Group vibrations and limitations of group vibration concept.

## UNIT-III

**Nuclear Magnetic Resonance**

General introduction and definition, chemical shift, spin-spin interaction, shielding and deshielding mechanism, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), complex spin-spin interaction between two, three, four and five nuclei (first order spectra), virtual coupling. Stereochemistry, concept of topicity, effect of enantiomeric and diastereomeric protons, hindered rotation, Karplus curve - variation of coupling constant with dihedral angle. Fourier transform technique and its advantages.

**Tools for simplification of complex NMR spectrum (chemical and instrumental): -** Deuteration, changing solvent, trifluoroacetylation, basification and acidification, lanthanide shift reagents, increased magnetic field strength, double resonance and nuclear overhauser effect (NOE), variable temperature probe. Concept of $^{2}$D-NMR spectroscopy-NOSY, COSY.

## UNIT-IV

**Carbon-13 NMR Spectroscopy**

General considerations, Comparison of $^{1}$H-NMR and $^{13}$C-NMR, Proton coupled and proton decoupled $^{13}$C-NMR, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Nuclear Overhauser effect.

**Composite Problems**

Problems involving the application of the above spectroscopic techniques (UV/Visible, IR, NMR and Mass) for structural elucidation of organic molecules.

**Mapping of Paper No. MSc/Chem/4/SEC2**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | M | S | S | W | S | S | S | S |
| **CO2** | S | S | M | S | M | S | S | W | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO5** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO6** | S | S | M | S | S | S | S | M | S | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO7** | M | S | M | S | M | S | M | W | S | S | S | M |
| **CO8** | M | M | M | S | W | S | S | W | S | S | S | S |
| **CO9** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO10** | S | S | M | S | S | S | S | M | S | S | S | S |
| **CO11** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings**


1. Organic Spectroscopy, W. Kemp, ELBS, London.
2. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming.
3. Spectrometric Identification of Organic compounds, R. M. Silverstein and G. C. Bassler.
4. Introduction to Spectroscopy, Donald L Pavia.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC5-I**
**Inorganic Chemistry Special-IV**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Discuss the synthesis, structure characteristic and chemical properties of metal carbonyls, metal nitrosyls.
CO2 Understand the synthesis and structural characteristics and important reactions of dinitrogen and dioxygen complexes.
CO3 Describe the various classifications of metal cluster compounds.
CO4 Understand various characteristics of metal boranes carboranes, metalloboranes and metallo-carboranes and learn about their various aspects.
CO5 Discuss the existence, stability and formation of metal-metal multiple bonds.
CO6 Understand the basics of organometallics and their applications.
CO7 Understand the classification of inorganic polymers and their comparison with organic polymers.
CO8 Know about boron-nitrogen polymers, silicones, coordination polymers, phosphorus-nitrogen compounds.
CO9 Describe the concept of Fluxionality and its dynamic equilibria in compounds such as $\eta^2$-olefin, $\eta^3$-allyl and dienyl complexes.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Metal л-Complexes**

Metal carbonyls: structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand, reactions of binuclear carbonyl.

## UNIT II

**Metal Clusters**

The isolobal analogy, isolobal fragments, Zintl ions; Higher boranes, carboranes, metalloboranes and metallocarboranes; Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds (quadrupole bonding in $[Re_2Cl_8^{2-}]$).

## UNIT-III

**Basics of Organometallics**

Nature of M–C bond in alkali/alkaline earth metal complexes, Metal carbenes and carbynes, Transition metal pi complexes with unsaturated molecules: Olefinic, Acetylenic, allyl and dienyl

(butadiene's, cyclobutadiene) complexes: Synthesis, structures and properties, $\eta^5$- complexes of cyclohexadienyl complexes.
Ferrocene: M.O. treatment, synthesis, structure and properties, $\eta^6$ complexes of benzene and its derivatives, Multidecker sandwich compounds.

**UNIT-IV**

**Inorganic Polymers** Classification, types of inorganic polymerization, comparison with organic polymers, boron-nitrogen polymers, silicones, coordination polymers, phosphorus-nitrogen compounds.

**Fluxional Organometallic compounds** Fluxionality and dynamic equilibria in compound such as $\eta^2$-olefin, $\eta^3$-allyl and dienyl complexes, Carbonyl scrambling.

**Mapping of Paper No. MSc/Chem/4/DSC5-I**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | S | M | S | S | M | M | S | S | M | M |
| **CO2** | S | S | S | M | S | M | S | S | S | M | M | M |
| **CO3** | S | S | S | S | M | M | S | M | S | S | S | M |
| **CO4** | M | M | S | M | S | S | M | M | S | M | S | M |
| **CO5** | S | M | S | S | S | S | M | S | S | M | M | M |
| **CO6** | M | S | S | M | S | M | S | S | S | S | S | S |
| **CO7** | S | S | M | S | M | M | S | S | S | S | M | M |
| **CO8** | S | S | S | S | M | S | S | S | S | S | S | S |
| **CO9** | S | S | S | S | M | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Organometallic Chemistry; R.C.Mehrotra and A.Singh, New Age International.
2. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J. Alexander; John Wiley.
3. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
4. Inorganic Chemistry, A Modern Introduction; T. Moeller; John Wiley and Sons.
5. Coordination Chemistry; Banerjea; Tata McGraw Hill.
6. Inorganic Chemistry, A Modern Introduction; T. Moeller; John Wiley and Sons.
7 Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. Mc Daniel and J.J. Alexander; John Wiley and Sons Inc.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC6-I**
**Inorganic Chemistry Special-V**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Discuss the Reaction Mechanism of Transition Metal Complexes.
CO2 Know the kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, and conjugate base mechanism.
CO3 Describe the Substitution reactions in square planar complexes, with reference to Trans effect and their mechanism.
CO4 Describe electron transfer reactions and mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions.
CO5 Learn about ESR spectroscopy and its application in inorganic analysis.
CO6 Know about basic concept of NMR and its utilization in the structural determination of inorganic compounds.
CO7 Discuss the basic principles, spectral parameters and display in Mossbauer spectroscopy to explain the oxidation states, coordination number and nature of metal ligand bond.
CO8 Understand Mossbauer technique for the determination of structure and bonding in iron and tin complexes.
CO9 Understand the Fundamental concepts, instrumentation application of absorption spectroscopy to analysis of inorganic substances.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Reaction mechanisms of Transition Metal Complexes-I**

Introduction, Classifications of mechanisms, Kinetics of octahedral substitution, Water exchange rates, Formation of complex aqueous ions, Anation reactions, Acid hydrolysis, Base hydrolysis, conjugate base mechanism. Substitution Reactions of square planar complexes, Mechanisms of substitution reactions, Trans Effect, Species with 17 electrons.

## UNIT-II

**Reaction mechanisms of Transition Metal Complexes-II**

Redox reactions, electron transfer reactions, general discussion and kinetic rate laws., mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions, two electron transfer reactions, metal ion catalysed reactions, mixed valence complexes and their electron transfer.

## UNIT-III

**Electron Spin Resonance Spectroscopy**

Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensor, application to transition metal complexes (having one unpaired electron) and inorganic free radicals such as $PH_4$, $F^{2-}$ and $[BH_3]^-$, Double resonance in EPR.

**Nuclear magnetic Resonance**

Nuclear relaxation, Factors affecting nuclear relaxation, effect of chemical exchange on spectrum and evaluation of reaction rate of fast reactions, Double resonance, Lanthanide shift reagents, an overview of NMR of other nuclides with emphasis on $^{31}P$, $^{19}F$, $^{195}Pt$ and $^{119}Sn$ NMR, Applications in inorganic chemistry.

## UNIT-IV

**Mossbauer Spectroscopy**

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of $Fe^{2+}$ and $Fe^{3+}$ compounds including those of intermediate spin, (2) $Sn^{2+}$ and $Sn^{4+}$ compounds – nature of M-L bond, coordination number, structure and (3) detection of oxidation state.

**Spectrophotometry and Colorimetry**

Fundamental concepts, instrumentation for absorption measurements, interferences, application of absorption spectroscopy and Colorimetry to analysis of inorganic substance.

**Mapping of Paper No. MSc/Chem/4/DSC6-I**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | M | S | S | S | M | S | S | S | S |
| CO2 | S | S | S | S | S | S | S | S | S | S | S | S |
| CO3 | S | S | S | S | S | S | S | S | S | S | S | S |
| CO4 | S | S | M | S | S | S | S | M | S | S | S | S |
| CO5 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO6 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO7 | S | S | S | S | M | S | S | M | S | S | S | S |
| CO8 | S | S | S | S | M | S | S | S | S | S | S | S |
| CO9 | S | S | S | S | M | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Mechanism of Inorganic Reactions; F.Basolo and R.G. Pearson, John Wiley and Sons, New York.
2. Inorganic Reaction Mechanism; M.L. Tobe; Nelson, Wlaton and Thames.

3. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia.
4. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
5. Instrumental methods of Analysis; L.L. Merrit, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
6. NMR, NQR, EPR and MB Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Horwood.
7. Fundamentals of Molecular Spectroscopy; C. N. Banwell; McGraw Hill.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC7-I**
**Inorganic Chemistry Special-VI**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Know about use of alkene and alkynes as ligands in organometallics.
CO2 Understand the synthesis and reactions of carbene and carbynes in organometallic chemistry.
CO3 Describe the oxidative addition, reductive elimination and migratory reactions in organometallics.
CO4 Know about various types of homogenous catalysis reactions and their utility in organic synthesis.
CO5 Know about use of organometallic polymers.
CO6 Understand about various types of organometallic compounds as drugs.
CO7 Know about radiopharmaceuticals, ionophores and sensors.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

**UNIT-I**

**Organometallics –I**

**Alkenes and Alkynes as ligands:** Synthesis of metal-alkene complexes, the concept of Umpolung, reactions of metal complexes of alkenes and alkynes, Pauson -Khand reaction.

**Carbene:** synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

**Carbynes:** synthesis and reactions

**UNIT-II**

**Organometallics –II**

**Oxidative addition:** Agostic and anagostic interactions, oxidative addition involving C-H bonds and cyclometallation, oxidative coupling, addition reactions of Si-H bond, C-C, C-Si and Si-Si bonds.

**Reductive elimination** in mononuclear and binuclear systems.

**Migratory insertion reactions:** General features, Insertion of alkenes and Alkyne.

**UNIT-III**

**Applications of Transition metal Organometallics as Catalysts**

Zeigler-Natta polymerization; homogeneous catalytic hydrogenation; alkene hydrogenation-Wilkinson Catalyst; Oxidation of olefins-Wacker's process; hydroformylation of olefins – the oxo process; Monsanto acetic acid process; Cativa Process; alkene (olefin) metathesis and Grubb's catalyst.

**UNIT-IV**

**Applications of Transition metal Organometallics as polymers, drugs**

Organometallic Polymers: Ferrocene based condensation polymers, rigid rod polymers.

Organometallic compounds as drugs: ruthenium compounds as general anticancer drugs, ferroquine as antimalarial drug and ferrocifen as breast cancer drug.

Organometallics as radiopharmaceuticals, ionophores and sensors.

**Mapping of Paper No. MSc/Chem/4/DSC7-I**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO2** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO5** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO7** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
3. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
4. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/SEC3-I**
**Inorganic Chemistry Special Practical-II**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Understand various instrumental techniques present in inorganic laboratories.
CO2 Develop the ability to demonstrate the qualitative and quantitative application of spectrophotometric technique.
CO3 Develop the ability to learn potentiometric pH and conductometric titrations.
CO4 Understand to perform experimentation and evaluation of the results.
CO5 Develop the ability to compile interpreted information in the form of lab record.
CO6 Develop the ability to express during Viva -Voce.

**Syllabus -**

**Instrumental methods of Analysis**

1. **Spectrophotometry**
a. Nickel, Molybdenum, Iron by extractive spectrophotometric method.
b. Iron-phenanthroline complex; Jobs method of continuous variation/mole ratio method.
c. Determination of pK value of an acid-base indicator.

2. **Potentiometry**
a. Determination of strength of HCl and $CH_3COOH$ in a mixture using NaOH.
b. Titration of weak acid with strong base using quinhydrone and determination of dissociation constant of acid.

3. **Conductometry**
Conductometric titration of $NH_4Cl$ vs NaOH, $CH_3COONa$ vs HCl, ($CH_3COOH$+HCl) vs NaOH.

4. **pH metry**
Determination of strength of HCl, $CH_3COOH$, etc.

**Data-Handling/Representation**
Using origin-Lab draw/ EXCEL data in different styles of graphs.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**
**Mapping of Paper No. MSc/Chem/4/SEC3-I**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | S | S | S | S | S | S | S | S | S |
| CO2 | S | S | S | S | S | S | S | S | S | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO6** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englewood.
2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London.
3. Inorganic Preparations: W. G. Palmer.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/SEC4-I**
**Inorganic Chemistry Special Practical-III**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Understand to prepare the sample of various coordination complexes.
CO2 Learn to perform experimentation and evaluation of the results.
CO3 Develop the ability to compile interpreted information in the form of lab record.
CO4 Develop the ability to express during Viva -Voce.

**Syllabus -**

**Preparations**

1. Preparation of hexaureachromium (III) chloride and estimation of $Cl^-$ ions in the prepared complex.
2. Preparation of pure sample of nitrosyl-bis-diethylthiocarbamatoiron(I) and estimation of Fe in the prepared complex.
3. Preparation of hexathioureaplumbous nitrate and estimation of Pb in the prepared complex.
4. Preparation of cobalt tetrathiocyanatomercurate (II) $Co[Hg(SCN)_4]$ and estimation of Hg in the prepared complex.
5. Preparation of tetramminecopper (II) sulphate $[Cu\ (NH_3)_4]SO_4$ and estimation of Cu in the prepared complex.
6. Preparation of dichloro-bis-(hydroxylamine)zinc(II) $[Zn(NH_2OH)_2Cl_2]$ and estimation of Zn in the prepared complex.
7. Preparation of aluminiumacetylacetonate $[Al(C_5H_7O_2)_3]$ and estimation of Al in the prepared complex.
8. Preparation of pentathioureadicuprous nitrate and estimation of Cu in the prepared complex.

**Note:** Demonstration of different software useful in Chemistry for drawing the structure of compounds.

**Data-Handling/Representation**

Using origin-Lab draw/ EXCEL data in different styles of graphs.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/4/SEC4-I**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO2** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Inorganic Synthesis, Book Series Vol 1-15, Wiley
2. Practical Inorganic Chemistry, G. Marr, B. W. Rockett
3. Bull. Chem. Soc., Japan 29, (1956) 852.
4. J. Chem. Soc 84, (1962) 3404.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC5-P**
**Physical Chemistry Special-IV**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Introduce advanced concepts of electrochemistry including overpotential, exchange current density and Butler-Volmer equation.
CO2 Discuss electrochemical energy sources like fuel cells and batteries.
CO3 Understand the forms, monitoring and mixed potential and passivity theory.
CO4 Prevention methods of corrosion and corrosion inhibitors.
CO5 Study the various statistical parameters used in the treatment of analytical data like types of errors, their sources and minimization along with Statistical evaluation of analytical data.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

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## UNIT-I

**Electrodics**

Rate of charge transfer reactions under zero field, under the influence of an electric field. The equilibrium exchange current density, the non-equilibrium drift-current density (Butler-Volmer) equation. High-field and low-field approximations. Physical meaning of the symmetry factor (β), A simple picture of the symmetry factor and its dependence on over potential. Polarizable and non-polarizable interfaces.

## UNIT-II

**Fuel Cells and Batteries**

The maximum intrinsic efficiency, Actual efficiency and Current-Potential relation in an electrochemical energy converter. Factors influencing the electrochemical energy conversion, The power output of an electrochemical energy converter. Electrochemical electricity generators (fuel cells). Brief idea about $H_2$-$O_2$ fuel cell, Hydrocarbon-air fuel cells, and Natural gas, CO-air fuel cells, Electricity storage: Some important quantities in electricity storage (like electricity storage density, energy density and power), Desirable conditions for an ideal storer, Storage of electricity using the lead-acid battery, Dry cell, Silver-Zinc cell and Sodium-Sulfur cell.

## UNIT-III

**Corrosion**

Electrochemistry of corrosion of metals, Factors affecting corrosion, Electrochemical cell formation, Polarization of metal electrode i.e., Concentration, Resistance and Activation polarization. Anodic and cathodic polarization curves (Evan's diagram). Electrochemical measurement of corrosion current density, corrosion potential and mixed potential theory and Tafel slope. Anodic passivation and passivation potential. Passivity theory.

**Protection methods against Corrosion**

Charge of Metal, Design improvement, Change of Environment, Anodic protection, Cathodic Protection, Protective coatings.

Corrosion inhibitors: Classification, mechanism, selection of corrosion inhibitors, inhibition efficiency and factors influencing & measurement of inhibition efficiency.

## UNIT-IV

**Errors and Evaluation**

Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data-determinate (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. Significance of the F test, the student 't' test, and the Chi-test, Linear Regression Analysis.

**Mapping of Paper No. MSc/Chem/4/DSC5-P**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | M | S | W | M | S | S | S | S |
| **CO2** | S | S | S | S | M | S | - | - | S | S | S | S |
| **CO3** | S | S | S | S | M | W | - | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | - | - | S | S | S | S |
| **CO5** | S | S | S | S | M | S | - | - | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. An Introduction to Electrochemistry, S. Glasstone
2. Corrosion Engineering, Fontana, Mc Graw Hill.
3. An introduction to metallic corrosion, Raj Narain.
4. Electrochemical Methods: Fundamentals and Applications, 2nd Ed., A. J. Bard and L. R. Faulkner John Wiley & Sons: New York, 2002.
5. Modern Electrochemistry 1: Ionics 2nd Ed., Springer (1998), J. O' M. Bockris & A. K. N. Reddy.
6. Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science 2nd Ed., Springer (2001), J. O' M. Bockris & A. K. N. Reddy.
7. Modern Electrochemistry 2A: Fundamentals of Electrodics 2nd Ed., Springer (2001), J. O' M. Bockris, A. K. N. Reddy and M. E. Gamboa-Aldeco.
8. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC6-P**
**Physical Chemistry Special-V**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Discuss the Langmuir adsorption isotherm and its kinetic derivation for non- dissociative and dissociative adsorption.
CO2 Express the knowledge about various terms associated with micelles.
CO3 Explain the thermodynamics of micellization.
CO4 Discuss wetting and its types.
CO5 Discuss Voltammetry, Polarography and Amperometric titrations.
CO6 Discuss the basic principle of various electro analytical techniques.
CO7 Discuss the Ion Selective and Enzyme Electrodes.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT-I

**Chemistry of Surfactants-I**

Adsorption of surface-active agents at Solid/Liquid, Liquid/Gas and Liquid/Liquid interfaces. Mechanism of adsorption, adsorption isotherm, effects of adsorption from aqueous solution on the surface properties of solid adsorbent, adsorption from non-aqueous solution. Determination of surface areas of solids. Gibb's and BET adsorption equation and its utilization to calculate surface concentration and surface area per molecule.

## UNIT-II

**Chemistry of Surfactants-II**

Surface active agents, classification of surface-active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, emulsions, micro emulsion. Wetting (spreading, adhesional and immersional wetting), Modification of wetting by surfactants. General consideration, Hard surface wetting and textile wetting.

## UNIT-III

**Voltammetry and Polarography**

General introduction, Theoretical consideration of classical polarography, Polarographic currents, Effect of capillary characteristics on diffusion current, Residual current, Half wave potential. Effect of complex formation on polarographic waves and mixed anodic cathodic waves, oxygen waves, instrumentation, cell electrodes and their modifications, Application of polarography. Modified voltametric methods, viz current sampled polarography, pulse polarography, stripping methods, amperometric titrations and their applications.

## UNIT-IV

**Electro Analytical & Potentiometric Methods**

Electrolytic and galvanic cell, Cell components, D.C. & A.C current in a cell, Reversible and irreversible cells, Nature of electrode potentials. Description of standard hydrogen electrode, Measurement of potentials, Sign conventions. Eo values and their calculations. Effect of concentration on cell potentials. Concept of Liquid Junction potential. Ohmic potential (IR drop). Polarization (overvoltage) phenomenon and its theories, Limitation to the use of standard electrode potentials.

Reference electrodes (Calomel, Ag/AgCl, Tl/TlCl) Metallic indicator electrodes (first, second and third type). Metallic Redox indicator electrode: Membrane and ion selective electrodes: Principle and design. Glass electrode, Gas sensing probes. Enzyme electrode. Principle and applications of potentiometric methods.

**Mapping of Paper No. MSc/Chem/4/DSC6-P**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | M | M | M | M | S | S |
| **CO2** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO5** | S | S | S | S | M | S | S | S | S | S | S | S |
| **CO6** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO7** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Surfactants and Interfacial Phenomena, Milton J Rosen, Joy T Kunjappu, Wiley.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.
6. An Introduction to Electrochemistry, S. Glasstone.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC7-P**
**Physical Chemistry Special-VI**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Discuss the structure determination of solids.
CO2 Understand the concept of Neutron and Electron diffraction methods.
CO3 Discuss the scope of nanomaterials and its characterisation techniques.
CO4 Discuss various terms about general properties of liquids.
CO5 Describe different types of intermolecular forces in liquids.
CO6 Introduce the basics of renewable energy source.
CO7 Understand the basics of photovoltaics, thermodynamics of light conversion and factors affecting solar cell efficiency.
CO8 Development of different types of solar cells and understand solar cell design.
CO9 Know about concentrator photovoltaics and photovoltaics storage system.
CO10 Discuss about thermodynamics principles in biological systems.
CO11 Know about muscular contraction and energy generation in mechanochemical system.
CO12 Describe optical techniques in biological systems.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

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## UNIT-I

**Diffraction Methods**

Lattice, Unit cell, Bragg's Law, Reciprocal lattice, Structure determination by X-ray diffraction, Powder method in detail, Structure of NaCl and KCl. Single crystal: Weissenberg method, Heavy atom method, Fourier synthesis factor. Brief method of intensity data collection, Neutron and electron diffraction methods, Comparison of XRD.

**Chemistry of Nanomaterials**

Definition, Historical perspective, Consequence of nanoscale, Nanoparticle morphology, Introduction to synthesis and characterization techniques for nanomaterials and applications of nanomaterials.

## UNIT-II

**General Properties of Liquids**

Liquids as dense gases, liquids as disordered solids, some thermodynamics relations, internal pressure and its significance in liquids, equation of state, critical constants, Different types of intermolecular forces in liquids.

**Ionic Liquids:** The thermal dismantling of an ionic lattice, characteristics of ionic liquids, The fundamental problems in the study of pure liquid electrolytes, models of simple ionic liquids: lattice-oriented models (Vacancy model, Hole model), quantification of the hole model, The Furth approach to the work of hole formation, distribution function for the sizes of the holes.

## UNIT-III

**Renewable energy sources**

Renewable energy resources: Biomass-Biofuels, Hydrogen, Solar energy. Related environmental and economic issues.

Introduction to Photovoltaics. Basic PV system design. Design and physics of solar cells, I-V characteristics, external and internal quantum efficiency. Thermodynamics of light conversion. Solar radiation and conversion efficiency. Factors influencing solar cell efficiency. Future trends in PV energy conversion. Silicon solar cells, alternatives to silicon, III-V materials for solar cells, thin film solar cells and third generation solar cells. Concentrator photovoltaics. Thermodynamic limit of light concentrators, Photovoltaics storage system.

## UNIT-IV

**Biophysical Chemistry**

Chemical bonds in biological systems; Properties of water; Thermodynamic principles in biological systems; Osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system. Introduction to protein folding problem. Cell Membrane and Transport of Ions: Structure and functions of cell membrane. Active transport across cell membrane, irreversible thermodynamics treatment of membrane transport.

Optical methods and applications: Optical techniques in biological systems: Absorption spectroscopy, Fluorescence spectroscopy, Linear and Circular Dichroism.

**Mapping of Paper No. MSc/Chem/4/DSC7-P**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO2** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO5** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO6** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO7** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO8** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO9** | S | S | S | S | M | S | S | M | S | S | S | S |
| **CO10** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO11** | S | S | W | S | M | S | S | S | S | S | S | S |
| **CO12** | S | S | S | S | M | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Principles of the Solid State, H.V. Keer, Wiley Eastern.
2. Instrumental methods of chemical analysis: Braun
3. Principles of Biochemistry, A.L.Lehninger, Worth Publishers.
4. Biochemistry, L.Stryer, W.H.Freeman.

5. Biochemistry, J.David Rawn, Neil Patterson.
6. Biochemistry, Voet and Voet, John Wiley.
7. Outlines of Biochemistry, E.E.Conn and P.K.Stumpf, John Wiley.
8. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, H.Dugas and C. Penny, Springer-Verlag.
9. Macromolecules: Structure and Function, F.Wold, Prentice Hall.
10. Biophysical Chemistry, Vol. 1-3, C. R. Cantor & Schimmel.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/SEC3-P**
**Physical Chemistry Special Practical-II**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**
CO1 Determine speed of sound of liquids using interferometer.
CO2 Understand and master the fundamentals of potentiometric experiments.
CO3 Determine equilibrium constants and dissociation constant of some organic liquids.
CO4 Determine magnetic moment and magnetic susceptibility of Mohr's salt.

**Syllabus -**

**Ultrasonic Interferometer**
1. To find ultrasonic speed of given organic binary liquid mixtures of different composition.
2. To study the effect of temperature on ultrasonic speed of given organic mixture.

**Potentiometry**
1. Determination of temperature dependence of EMF of a cell.
2. To determine the thermodynamic parameter for a reaction from emf measurement.
3. To determine the formal potential of a redox couple, $Fe(CN)_6^{3-}/Fe(CN)_6$ in different media.
4. To determine the pH of a series of buffer solution by potentiometric method.
5. To determine the solubility product of AgCl and to determine instability constant of $Ag(NH_3)^{2+}$complex.
6. To determine the activity of hydrogen ion in acid medium using hydrogen electrode, hence to determine the ionic product of water and hydrolysis constant of sodium acetate.
7. To determine the degree of hydrolysis and hydrolysis constant of aniline, HCl by potentiometry.
8. To determine the concentration of a reductant or an oxidant i.e., Ferrous ammonium sulphate and Ceric sulphate by a potentiometric redox titration.
9. To determine the amount of KI and KCl present in a mixture by potentiometric titration.

**Equilibrium and Dissociation Constant**
1. To determine the equilibrium constant of an esterification reaction between acetic acid and ethanol.
2. To determine the equillibrium constant of the following reversible reaction:
   $2\,Ag^{+} + CaSO_4 \longrightarrow Ag_2SO_4\,(s) + Ca^{2+}$

**Magnetic Moment and Magnetic Susceptibility**
1. To determine the magnetic susceptibility of Mohr's salt at room temperature and hence the magnetic moment by using Gouy balance.

**Note:** Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

**Data-Handling/Representation**
Using origin-Lab draw/ EXCEL data in different styles of graphs.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/4/SEC3-P**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | M | - | S | S | S | S |
| **CO2** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | S | S | M | - | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Practical Chemistry, A. M. James, F. E. Pricherd, Longman.
2. Practical Physical Chemistry, B. P. Levitt and Findley's, Longman.
3. Practical Physical Chemistry, S. R. Palit, S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R. C. Das, B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/SEC4-P**
**Physical Chemistry Special Practical-III**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Describe the concept of phase diagram for two and three component system.
CO2 Demonstrate the effect of temperature on corrosion.
CO3 Illustrate and master the fundamentals of conductometric titrations in aqueous media.
CO4 Determine the thermodynamic parameter for reactions.

**Syllabus –**

**Turbidimetry**

1. To find the turbidity of given solution by using Nephaloturbidity meter.

**Phase Rule**

1. To verify the phase rule for a given two component Azeotropic mixtures.
2. To verify the phase rule for a given three component Azeotropic mixtures.
3. To determine the transition temperature of given salt hydrate like Sodium sulphate, Strontium sulphate or Sodium thiosulphate.
4. To determine the critical solution temperature of phenol water system.

**Corrosion**

1. To find corrosion rate of any metal or alloy in given acidic solution.
2. To study the effect of temperature on the corrosion rate.

**Dipole Metry**

1. To find dipole moment of given liquid such as Chlorobenzene, Chloroform,
2. Nitrobenzene etc. by using dipole meter.

**Conductometry**

1. Study of conductometric titration of $NH_4Cl$ versus NaOH solution and comment on nature of graph.
2. Study of conductometric titration of $CH_3COONa$ versus HCl and comment on nature of graph.
3. Study conductometric titration of $MgSO_4$ versus $Ba(OH)_2$ and comment on nature of graph.
4. To study stepwise neutralization of polybasic acid i.e., oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the graph.
5. To determine the relative strength of two acids using conductometer.
6. To determine the solubility of a sparingly soluble salt in water by conductance measurements.
7. Study conductometric titration of $BaCl_2$ and $K_2SO_4$ and comment on nature of graph.
8. To find CMC value of a given surfactant solution.

**pH metry**

1. To determine the thermodynamic parameter for a reaction from pH measurement.
2. To prepare a series of buffer solution and to check resist in its pH value by pH meter method.
3. To determine the degree of hydrolysis and hydrolysis constant of aniline, HCl by pH metrically.
4. To determine the concentration of a reductant or an oxidant i.e., Ferrous ammonium sulphate and Ceric sulphate by a pH metric titration.

5. To determine the amount of KI and KCl present in a mixture by pH metric titration.
6. To determine the strength of polybasic acid with the help of pH meter.

**Note:** Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

**Data-Handling/Representation**

Using origin-Lab draw/ EXCEL data in different styles of graphs.

**Experiment & Written part** **Marks: 70**

**Lab record** **Marks: 10**

**Viva-voce** **Marks: 20**

**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/4/SEC4-P**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | M | M | S | S | S | S |
| **CO2** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | M | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Practical Chemistry, A. M. James, F. E. Pricherd, Longman.
2. Practical Physical Chemistry, B. P. Levitt and Findley's, Longman.
3. Practical Physical Chemistry, S. R. Palit, S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R. C. Das, B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand, McGraw Hill.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC5-O**
**Organic Chemistry Special-IV**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 Become familiar with systematic (Hantzsch-Widman) nomenclature for monocyclic and fused ring systems.
CO2 Understands the method of synthesis and the chemical reactions of three and four membered heterocyclic compounds such as oxirane, azirene, oxazirane, diaziridines, Oxetane and azetidine, thiirane.
CO3 Describes the basic character, methods of synthesis and Reactions with mechanistic details of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole.
CO4 Demonstrates the general method of synthesis and chemical reactions of purines and pyrimidines.
CO5 Get to know mechanistic details of Arndt-Eistert synthesis Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzil benzillic acid rearrangements, MItsunabu, stroke enamine synthesis, Shapiro reaction.
CO6 Understands the need of green chemistry and its principles.
CO7 Get an elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted.
CO8 Discuss the concept of atom economy for different types of reactions.
CO9 Apply concepts of green chemistry for the synthesis of Adipic acid and Ibuprofen.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT – I

**Heterocyclic compounds**

Systematic (Hantzsch-Widman) classification and nomenclature for monocyclic and fused ring systems. Criteria of Aromaticity (Bond length, Ring current, Chemical shifts in $^{1}H$).
General synthesis and reactions (including mechanism) of the followings:
**Three-membered heterocycles:** oxirane, azirine, aziridines, oxazirane, thiirane, Diaziridines.
**Four-membered heterocycles:** Oxetane and azetidine.

## UNIT – II

General synthesis and reactions (including mechanism) of the followings:
**Five membered Heterocycles**: Synthesis and reaction including mechanism of the following: Imidazole, Thiazole, Oxazole, Isooxazole, Isothiazole. Comparison of their basic character.
General synthesis and reactivity of purines and pyrimidines.

## UNIT – III

**Reactions & Rearrangements:** A detailed study including mechanism, stereochemistry of following: Fritsch-Butenberg-Wiechell, Benzil- Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofmann, Curtius, Lossen, Schmidt, Baeyer-Villiger, Mitsunabu and Shapiro reaction, Stroke enamine synthesis.

## UNIT – IV

**Principle of Green chemistry and its applications**

Basic Principle and need of green chemistry, Different tools for green synthesis (Elementary idea of green reagent, green solvent, green catalyst, solid phase, Microwave and ultrasound assisted) atom economy, synthesis involving basic principle of green chemistry-synthesis of adipic acid and BHC synthesis of Ibuprofen.

**Mapping of Paper No. MSc/Chem/4/DSC5-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO2** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO3** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO4** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO5** | S | S | M | S | M | S | M | M | S | S | S | S |
| **CO6** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO7** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO8** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO9** | S | S | S | S | S | S | M | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Heterocylic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
2. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergaman Press.
3. Handbook of Heterocyclic Chemistry, Alan Katritzky, Christopher Ramsden, John A. Joule and Viktor Zhdankin, 3rd Edition, Elsevier.
4. Heterocyclic Chemistry, Volume I, Gupta, Kumar, Gupta.
5. Heterocyclic Chemistry, Volume II, Gupta, Kumar, Gupta.
6. Heterocyclic Chemistry, Volume III, Gupta, Kumar, Gupta.
7. Modern Synthetic Reactions, H.O. House, W. A. Benzamin.
8. Advanced Organic Chemistry Reactions, Mechanisms and Structures, J. March, Wiley.
9. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
10. Handbook of Green Chemistry- Green Catalysis- Paul T. Anastas, Robert H. Crabtree, Wiley-VCH.
11. Methods and Reagents for green synthesis: An introduction, Pietro Tundo, Alvise Perosa, F. Zecchin, Wiley.
12. Reactions, Rearrangements and Reagents, S N Sanyal.
13. Organic Name Reactions: A Unified Approach, Goutam Brahamchari.
14. Name Reactions: A Collection of Detailed Mechanisms and Synthetic Applications by Jie Jack Li from Springer.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC6-O**
**Organic Chemistry Special-V**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course Outcomes:**

CO1 After completion of course the students will be able to apply the concepts of Disconnection approach for the synthesis of different target molecules in organic chemistry.
CO2 Demonstrate about various terms used in disconnection approach like synthons, synthetic equivalents, functional group interconversions and importance of order of events.
CO3 Understands about one group C-X and two group C-X disconnections, one group C-C disconnection.
CO4 To understand the practical aspects of chemoselectivity, regioselectivity.
CO5 Understand the concept of reversal of polarity and amine synthesis.
CO6 Discuss the application of Wittig reagents and acetylene for the synthesis of alkenes.
CO7 Understands the application of aliphatic nitro compounds in organic synthesis.
CO8 Discuss two group C-C disconnection utilizing Diels Alder reactions, 1,3-difunctionalized compounds, unsaturated carbonyl compounds, 1,5-difunctionalized compounds, Michael addition and Robinson Annelation.
CO9 Describes the strategy about control in carbonyl condensations.
CO10 Understands the principles of protection and deprotection approach in synthetic organic chemistry with special reference to alcoholic, amino, carbonyl and carboxylic groups and able to apply in organic synthesis.
CO11 Discuss the chemical and biological catalysis, nomenclature, and classification, of enzymes, Fischer's lock, and key and Koshland's induced fit hypothesis.
CO12 Describe the kinetics of Enzyme catalyzed reactions, Michaelis-Menten and Lineweaver-Burk plots and kinetics of reversible and irreversible inhibition.
CO13 Illustrate the mechanisms of enzyme catalyzed reactions, Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. To understand mechanism of action of chymotrypsin, carboxypeptidase A and Glucose-6-phosphate Isomerase.
CO14 Describes about Cofactors as derivatives of vitamins & knowledge of coenzymes, prosthetic groups, apoenzymes. structure and biological functions and mechanisms of reactions catalyzed by coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, $NAD^+$, $NADP^+$, FMN, FAD by the above cofactors.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT – I

**Disconnection Approach-I**

An introduction of synthons and synthetic equivalents, General principles of the disconnection approach, Functional group interconversions, Importance of order of events in organic synthesis, One group C–X and two group C–X disconnections, Chemoselectivity, Regioselectivity, Alcohols and carbonyl compounds, Reversal of polarity (Umpolung), Amine synthesis.

## UNIT-II

**Disconnection Approach-II**

Alkene synthesis: Use of Wittig reagents, Acetylenes and aliphatic nitro compounds in organic synthesis. Diel's-Alder reaction, 1,3-difunctionalised compounds, α, β-unsaturated carbonyl compounds, 1,5-difunctionalised compounds. Michael addition and Robinson annelation, control in carbonyl condensations.

**Protective Groups**

Principle of protection of alcoholic, amino, carbonyl and carboxylic groups.

## UNIT – III

**Enzymes**

Introduction, Nomenclature and classification, remarkable properties of enzymes like catalytic power, specificity and regulation, chemical and biological catalysis, Fischer's lock and key model and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling. Enzyme kinetics: Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition with examples (Kinetics excluded).

**Mechanism of Enzyme Action**

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion.

## UNIT - IV

Examples of some typical enzyme mechanisms for Chymotrypsin, Carboxypeptidase-A and Glucose-6-phosphate Isomerase.

**Co-enzyme Chemistry**

Cofactors as derived from vitamins, Coenzymes, Prosthetic groups, Apoenzymes. Structure and biological function of coenzyme-A, thiamine pyrophosphate, pyridoxal phosphate, $NAD^+$, $NADP^+$, FMN, FAD. Mechanisms of reactions catalysed by the above cofactors.

**Mapping of Paper No. MSc/Chem/4/DSC6-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO2** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO3** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO4** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO5** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO6** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO7** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO8** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO9** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO10** | S | S | M | S | S | S | M | S | S | S | S | S |
| **CO11** | S | S | S | S | S | S | S | S | S | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO12** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO13** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO14** | S | S | S | S | S | S | M | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Organic Chemistry, Vol. 2, I.L. Finar, ELBS.
2. Natural Products: Chemistry and Biology Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
3. Outlines of Biochemistry, Cohn & Stumpf.
4. Understanding Enzymes, Trevor Palmer, 3rd edition.
5. Principles of Biochemistry, A. L. Lehninger.
6. Biochemistry, L. Stryer, W.H.Freeman.
7. Biochemistry, J.David Rawn, Neil Patterson.
8. Biochemistry, Voet and Voet, John Wiley.
9. Designing Organic Synthesis, S. Warren, Wiley.
10. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/DSC7-O**
**Organic Chemistry Special-VI**

**Credits-4** **Total Marks = 100**
**Time: 3 Hrs.** **70 (EM) + 30 (IA)**

**Course outcomes:**

CO1 Demonstrate understanding of the basic principles of drug action, design and the terminology involved therein.

CO2 Apply the knowledge of drug design in developing new drugs using rational approach to drug design.
CO3 Describe synthesis, structure elucidation and medicinal uses of penicillins and cephalosporins as cell wall biosynthesis and protein synthesis inhibitors.
CO4 Explain synthesis, general mode of action and medicinal uses of listed classes of drugs.

**Note for the paper setter:** The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

## UNIT – I

**Drug Design**
Classification and discovery of new drugs, Therapeutic index, $LD_{50}$ and $ED_{50}$, Naming of (new) drugs.
Elementary idea about drug action: The receptor role, Neurotransmitters and Receptors, Ion channels and their control, Membrane bound enzymes: Activation/deactivation, Design of agonists and antagonists.
**Drug development**
Screening of natural products, Isolation and purification, Structure determination, Structure-activity relationships (SAR), Synthetic analogues, Isosteres and bioisosteres, Concept of lead compounds.
Brief overview of pharmacokinetics and pharmacodynamics, concept of prodrugs and synergism.

## UNIT – II

**Antibiotics**
Penicillins and semi-synthetic penicillins: Synthesis, Structure elucidation and Medicinal uses of Penicillin, Streptomycin and Tetracyclins, Problems of sensitivity to acids, β-lactamases and narrow spectrum of activity of penicillin G, solving these problems leading to the development of penicillin V, oxacillin, cloxacillin, ampicillin, amoxicillin and carbenicillin.

## UNIT – III

**Synthesis, General Mode of Action and Medicinal Uses of Important Drugs in the Following Categories**
**Anti-inflammatory agents**: Salicylic acid derivatives, Indomethacin, Antipyrine, Amino-antipyrine, Aminopyrine, Mefanimic acid, Ibuprofen, Diclofenac.
**Cardiovascular Drugs:** Calcium channel blockers and β-blockers: Sorbitrate and verapamil, atenolol.

**AIDS and drugs against HIV**: How HIV infect the system, Structure and mode of action of important drugs against HIV (nucleoside reverse transcriptase inhibitors): AZT, ddI, ddC, d4T and 3TC (synthesis only of AZT).

**UNIT – IV**

**Synthesis, General Mode of Action and Medicinal Uses of Important Drugs in the Following Categories**

**Antineoplastic agents**: Mechlorethamine, Cyclophosphamide, Chlorambucil, Aminopterin, 6-Mercaptopurine and Carmustine.

**Antimalarials:** Chloroquine, Primaquine, Chloroguanide, Pyrimethamine.

**Oral Hypoglycemic Drugs: Insulin and Synthetic Hypoglycemic Agents:** Glipizide, Tolbutamide, Tolazamide, Metformin.

**Mapping of Paper MSc/Chem/4/DSC7-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | W | S | M | S | S | S | S | S |
| **CO2** | S | S | S | S | S | S | M | S | S | S | S | S |
| **CO3** | S | S | S | S | W | S | M | S | S | S | S | S |
| **CO4** | S | S | S | S | W | S | M | M | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Suggested Readings:**


1. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F.Dorge.
2. Burger's Medicinal Chemistry and Drug Discovery, Vol-I Ed.M.D. Wolf, John, Wiley.
3. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
4. Introduction to Medicinal Chemistry, A. Gringuage, Wiley, VCH.
5. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/SEC3-O**
**Organic Chemistry Special Practical-II**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Understand the methods of separations of binary (liquid-liquid, liquid-solid or solid-solid) organic mixtures.
CO2 Identification of different functional groups using qualitative analysis.
CO3 Describe the significance of melting point and boiling point in structure elucidation of organic compounds.
CO4 Prepare derivatives of different organic functionalities.
CO5 Describes the characterize given organic compounds by interpreting their $^{1}$H-NMR and FT-IR spectra.
CO6 Performs experimentation and evaluation the results Quantitatively as well as qualitatively.
CO7 Develops the ability to compile information in the form of lab records.
CO8 Able to defend Viva-voce examination.

**Syllabus –**

1. **Qualitative Analysis:** Separation of components of a binary (liquid-liquid, liquid-solid or solid-solid) organic mixture using physical and chemical method. Characterization of these components with the help of chemical analysis and derivative formation.
2. Spectroscopic confirmation of the components of organic compounds (as available) using IR and NMR tools (IR & NMR spectra will be provided).
3. **Quantitative Analysis: Titrimetric Method**
   a. Estimation of Amines/phenols using bromate-bromide solution.
   b. Determination of iodine and saponification values of oil samples.
   c. Determination of concentration of Glucose/or Sucrose in the given solution (Fehling solution method).

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/4/SEC3-O**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | S | S | S | S | S | S | S | S | S |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO2** | S | S | M | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | M | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | M | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | M | S | S | S | S | S | S | S | S | S |
| **CO6** | S | S | M | S | S | S | S | S | S | S | S | S |
| **CO7** | S | S | M | S | S | S | S | S | S | S | S | S |
| **CO8** | S | S | M | S | S | S | S | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. A Guide to spectroscopy in Organic Chemistry by PAVY
2. Spectrometric Identification of Organic Compounds, Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C.Morrile, John Wiley and Sons, New York.
3. Organic Spectroscopy, 3rd Ed., by William Kemp. John Wiley & Sons.
4. Spectroscopic Methods in Organic Chemistry, D.H. William & Ian Fleming.
5. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
6. Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
7. An Introduction to Practical Biochemistry, by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
8. Practical Organic Chemistry' by Mann and Saunders.
9. Textbook of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.

**M.Sc. Chemistry (4th Sem.)**
**MSc/Chem/4/SEC4-O**
**Organic Chemistry Special Practical-III**

**Credits-4**
**Time: 8 Hrs./week** **Max. Marks: 100**

**Course outcomes:**

CO1 Able to quantitatively estimate carbohydrates, ascorbic acid, amino acids, proteins, urea colorimetrically.
CO2 Purifies natural products from raw material.
CO3 Performs experimentation, evaluation, compilation and presentation of results.
CO4 Skill development to explain the results.

**Syllabus –**

1. **Colorimetric or Spectrophotometric (UV-Vis) determination of the following:**
   Carbohydrates
   Ascorbic acid
   Amino acids
   Proteins
   Urea
2. **Extraction of organic compound from natural products:**

   a. Caffeine from tea leaves.
   b. D (+) Glucose from cane sugar
   c. Cystine from human hair
   d. Isolation of nicotine from tobacco.
   e. Isolation of lactose from milk.
   f. Isolation of Casein from milk.
   g. Ascorbic acid from fruit juice.

**Experiment & Written part** **Marks: 70**
**Lab record** **Marks: 10**
**Viva-voce** **Marks: 20**
**Note: The evaluation will be done by external and internal examiners.**

**Mapping of Paper No. MSc/Chem/4/SEC4-O**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | S | S | S | S | S | S | S | S | S |
| CO2 | S | S | S | S | S | S | S | S | S | S | S | S |
| CO3 | S | S | S | S | S | S | S | S | S | S | S | S |
| CO4 | S | S | S | S | S | S | -- | S | S | S | S | S |

**S = Strong, M = Medium, W = Weak**

**Books Suggested:**


1. Elementary Practical Organic Chemistry by Arthur I.Vogel Longmans, Green and Co. 1958.
2. An Introduction to Practical Biochemistry, by David T. Plummr, Tata McGraw Hill Publishing Company, Ltd., N. Delhi, 1988.
3. Practical Organic Chemistry by Mann and Saunders.
4. Text Book of Vogel's Practical Organic Chemistry by Longman Group, B.S. Furness et al., Ltd.
5. Experiments in Organic Chemistry Louis F. Fieser O.C. Heath and Company Boston, 1955.
6. Organic Synthesis, Collective Vol. I.
7. Laboratory Manual in Organic Chemistry by R.K. Bansal, Wiley Eastern Ltd., New Delhi-1980.
8. A Handbook of Organic Analysis Qualitative and Quantitative by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975).
9. Systematic Qualitative Organic Analysis by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.
10. A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966.
11. Elementary Practical Organic Chemistry by Arthur I. Vogel, CBS Publishers & Distributors.