

**B. Sc. (Hons.) Chemistry: Semester - I**  
**Inorganic Chemistry**  
**Paper No. - I**

**Unit I. Atomic Structure**

*Nature and Path of Electorn:* Idea of de Broglie matter waves, Heisenberg uncertainty principle, Atomic orbitals, Shapes of s, p, d orbitals.

*Quantum Mechanical Approaech:* Schrodinger wave equation, significance of  $\psi$  and  $\psi^2$ , quantum numbers, radial and angular wave functions and probability distribution curves.

*Electron Distribution:* Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge.

**Unit II. Periodic Properties**

*Atomic and Ionic size:* Definition and explanation of atomic radius, ionic radius, Covalent radius, Vander waals radius. Variation of atomic size along a period and in a group.

*Ionization Energy:* Definition and Explanation, Successive ionization energy, Factors affecting ionization energy. Variation of ionization energy along a period and in a group. Applications of ionization energy to chemical behavior of an element.

*Electron Affinity:* Definition and Explanation, Successive electron affinity, Factors affecting electron affinity. Variation of electron affinity along a period and in a group. Applications of electron affinity to chemical behavior of an element. Difference between ionization energy and electron affinity.

*Electro Negativity:* Definition and Explanation, Factors affecting electron negativity. Variation of electron negativity along a period and in a group. Pauling's approach of electron negativity. Calculations of electron negativity. Applications of electron negativity to bond properties such as percent ionic character, bond length, bond angle.

**Unit III. Oxidation and Reduction**

*Oxidation and reduction:* Oxidation-reduction reactions, oxidation state, rules for the determination of oxidation states,

*Redox potential:* Electrode potential, standard electrode potential and their determination, electrochemical series, applications of electrochemical series.

**Unit IV. Acids and Bases**

**Acids and bases:**

*Introduction:* Definition of acids and bases according to Arrhenius, Bronsted and Lowery and Lewis

*Other theories:* Solvents system concept for acids and bases, Lux-Flood concept for acids and bases and their limitations.

*Hard and soft acids and bases:* Definition, Pearson's HSAB concept, Acid Base Strength and Hardness and Softness., Classification of Acids and Bases as Hard and Soft, Acid Base Strength and Hardness and Softness.

**Books suggested:**

1. Inorganic Chemistry by A. G. Sharp.
2. Inorganic Chemistry by G. L. Miessler and D. A. Tarr.
3. J.D.Lee, Concise Inorganic Chemistry, 5<sup>th</sup> edn., Blackwell Science, London
4. Modern approach to Inorganic chemistry – Bell and Lott
5. Principles of Inorganic Chemistry – Emelns and Anderson

**B.Sc. (Hons.) Chemistry: Semester – I**  
**Organic Chemistry**  
**Paper No. - II**

**Unit I: Structure and Bonding**

Hybridisation, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clathrates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

**Unit II: Mechanism of Organic Reactions**

Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents- electrophilic and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates- carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species.

Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, Kinetic and stereochemical studies).

**Unit III: Alkanes and Cycloalkanes**

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, Classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties and chemical reactions of alkanes.

Mechanism of free radical halogenations of alkanes: orientation, reactivity and selectivity. Cycloalkanes- nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring: banana bonds.

**Unit IV: Arenes and Aromaticity**

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekulé structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture. Aromaticity: the Hückel rule, aromatic ions

**Books Recommended**

1. Organic Chemistry (Vol. I)- S M Mukherji, S P Sing & R P Kapoor, New Age Publishers, New Delhi.

2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, New Delhi.
4. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.

**B.Sc. (Hons.) Chemistry: Semester-I**  
**Physical Chemistry**  
**Paper No. - III**

**Unit I. Gaseous States**

Gas Laws, Ideal Gas Equation, Dalton's Law of Partial Pressure, Graham's Law of Diffusion, Postulates of Kinetic Theory of Gases, Kinetic Gas Equation. Deviation from Ideal Behavior: Effect of Temperature and Pressure.

Molecular Velocities: Root Mean Square, Average and Most Probable Velocities. Qualitative Discussion on Maxwell's Distribution of Molecular Velocities. Collision Properties: Collision Number, Mean Free Path, Collision Diameter and Collision Frequency. Liquefaction of Gases (based on Joule - Thomson effect).

Critical Phenomena: PV Isotherms of Real Gases, Continuity of States, van der Waals Equation, Isotherms of van der Waals Equation, Relationship between Critical Constants and van der Waals Constants, Law of Corresponding States, Reduced Equation of State.

**Unit II. Liquid State.**

Descriptions of Liquids, Structure of Liquids (a qualitative description), Intermolecular Forces, Structural Differences between Solids, Liquids and Gases.

Liquid Crystals, Vapour pressure-Temperature Diagram, Classification of Liquid Crystals, Difference between Liquid Crystals. Structure of Smectic, Nematic and Cholestric Liquid Crystals. Thermography and seven segment cell.

**Unit III. Chemical Kinetics-I**

Chemical Kinetics and its Scope, Rate of a Reaction, Rate Laws, Factors Influencing the Rate of Reaction: Concentration, Temperature, Pressure, Catalyst. Rate Constant, Elementary and Complex Reactions, Molecularity, Order of Reactions, Concentration and Temperature Dependence of Rates, Mathematical Characteristics of Simple Chemical Reactions - Zero Order, First Order, Second Order, Pseudo Order, and their Half-life Expressions. Determination of Order of Reaction - Differential Method, Method of Integration, Half-life Method and Isolation Method.

**Books Recommended:**

1. Essentials of Physical Chemistry, B.S. Bahl, G.D.Tuli and Arun Bahl, S. Chand & Company Ltd.
2. A Text Book of Physical Chemistry, A.S. Negi and S.C. Anand, New Age International Publishers.
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.
4. Physical Chemistry through Problems, S. K. Dogra and S. Dogra Wiley Eastern Ltd.

**B.Sc.(Hons.) Chemistry: Semester - I**  
**Inorganic Chemistry Practical**

**Qualitative Analysis:**

Semi micro qualitative analysis of inorganic salt mixtures containing:

**Anions:** (including interfering radical)

Acetate, sulphite, Nitrate, chloride, bromide and phosphate

**Cations:**

Group 0 cation: Ammonium

Group I cations: Lead, silver, mercurous.

Group II cations: Lead, mercuric, copper, cadmium, bismuth, antimony, tin.

**Book suggested:**

1. Vogel's Text Book of Inorganic Qualitative Analysis, 4 th edition, ELBS, London, 1974. .
2. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd edition, The National Publishing Company, Chennai, 1974.

**B.Sc. (Hons.) Chemistry: Semester-I**  
**Organic Chemistry Practical**

1. Laboratory Techniques
  - (a) Determination of melting point of naphthalene 80-82°C. Benzoic acid 121.5-122°C. urea 132.5-133°C, Succinic acid 184.5-185°C. Cinnamic acid 132.5-133°C, Salicylic acid 157.5-158°C. Acetanilide 113.5-114°C, m-dinitrobenzene 90°C.
  - (b) Determination of boiling point.  
Ethanol 78°C, Cyclohexane 81.4°C. Benzene 80°C.
  - (c) Mixed melting point determination.  
Urea-cinnamic acid mixture of various compositions (1:1, 1:4, 4:1).
  - (d) Distillation of ethanol water mixture using water condenser. Distillation of nitrobenzene + aniline using air condenser.

**B.Sc. (Hons.) Chemistry: Semester-I**  
**Physical Chemistry Practicals**

**Viscosity and Surface Tension**

1. To determine the percentage composition of a given mixture (non-interacting systems) by viscosity method.
2. To determine the viscosity of amyl alcohol in water at different concentrations and calculate the excess viscosity of these solutions.
3. To determine the percentage composition of a given binary mixture by surface tension method (Acetone and Ethyl Ketone).

**Chemical Kinetics**

1. To determine the specific reaction rate of the hydrolysis of methyl acetate / ethyl acetate catalysed by hydrogen ions at room temperature..
2. To study the effect of acid strength on the hydrolysis of an ester.
3. To compare the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying the kinetics of hydrolysis of ethylacetate..

4. To study kinetically the reaction rate of decomposition iodide by  $\text{H}_2\text{O}_2$ .
5. Any other experiment(s) introduced during the year.

**Books Suggested**

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.



**B. Sc. (Hons.) Chemistry: Semester - II**  
**Inorganic Chemistry**  
**Paper No. -IV**

**Unit I: Chemical Bonding-I**

*Ionic Bonding:* Definition and explanation, Factors affecting the formation of ionic bond, Energy changes in the formation of ionic bond, Lattice energy and Born-Haber cycle. Polarizing power and polarizability of ions, Fajan's rule.

*Covalent bonding:* Definition and explanation, Sigma and pi-bond, Valence bond theory of covalent bonding and its limitations, Percentage ionic character in covalent bond from dipole moment.

*Metallic bonding:* Definition and explanation, Free electron theory of metallic bonding, valence bond and band theories, Effects of metallic bonding on metallic properties.

**Unit II: Chemical bonding-II**

*Concept of hybridization:* Definition and explanation of  $ds^2sp^3$  hybridization by taking example of  $[Ni(CN)_4]^{2-}$ ,  $d^2sp^3$  hybridization by taking example  $PCl_5$ ,  $d^3sp^3$  hybridization by taking example  $SF_6$ ,  $d^3sp^3$  hybridization by taking example  $IF_7$ .

*Molecular Orbital Theory:* Basic principle of MOT, LCAO, Bonding and anti-bonding molecular orbital, Energy level diagram for molecular orbital. Rules for adding electrons in MO's, Bond order, Molecular orbital diagram of homo nuclear diatomic molecules such as  $H_2$ ,  $N_2$ ,  $O_2$ , and  $Ne_2$ .

**Unit III: Structure and Shape of the molecule**

*Lewis structure:* Lewis structure and formal charge, resonance structure,

*VSEPR Theory:* Postulates and explanation, Applications in explaining geometry and bond angle in molecules such as  $CH_4$ ,  $NH_3$ , and  $H_2O$ . Limitations of VSEPR theory.

**Unit IV: Group I Elements**

*Hydrogen :* Isotopes (separation method not needed). Ortho and parahydrogen – Hydrides and their classification.

*Alkali metals:* Chemical properties of the metals: reaction with water, air, nitrogen; uses of s-block metals and their compounds, Compounds of s-block metals: oxides, hydroxides, peroxides, superoxides-preparation and properties; oxo salts-carbonates, bicarbonates, nitrates; halides and

polyhalides; anomalous behavior of Li , Complexes of *s*-block metals, biological importance, organometallic compounds of Li.

**Books suggested:**

1. D.F. Shriver and P.W. Atkins, Inorganic Chemistry, 3rd edn., Oxford University Press.
2. J.D.Lee, Concise Inorganic Chemistry, 5th edn., Blackwell Science, London
3. Inorganic Chemistry by G.L. Miessler and D.A. Tarr.
4. Inorganic Chemistry by A. G. Sharp.

**B.Sc. (Hons.) Chemistry: Semester - II**  
**Organic Chemistry**  
**Paper No. - V**

**Unit I: Stereochemistry of Organic compounds**

Concept of isomerism. Types of Isomerism

Optical isomerism-elements of symmetry, molecular chiral enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro distereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Relative and absolute configuration, Sequence rules, D & L and R & S systems of nomenclature.

Geometric isomerism-determination of configuration of geometric isomers. E & Z system of nomenclature, geometric isomerism in oximes and acyclic compounds. Conformational isomerism- conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of monosubstituted cyclohexane derivatives. Newman projection and Sawhorse Difference configurations and conformations.

**Unit II: Alkenes, Cycloalkenes, Diens and Alkynes**

Nomenclature of alkenes, methods of formation of, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hoffman elimination, physical properties and relative stabilities of alkenes.

Chemical reactions of alkenes- mechanisms involved in hydrogenation, electrophilic and free radicals, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction, Epoxidation,

Ozonolysis, hydration, hydroxylation, oxidation with  $\text{KMnO}_4$ . Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. industrial applications of ethylene and propene.

Methods of formation, conformation and chemical reactions of cycloalkenes.

Nomenclature, structure and bonding in alkynes. Method of formation. Chemical reactions of alkynes, Acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.

**Unit III: Alkyl halides and aryl halides**

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides,  $\text{S}_\text{N}2$  and  $\text{S}_\text{N}1$  reactions with energy profile diagrams.

Polyhalogen compounds: chloroform, carbon tetrachloride.

Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

#### **Unit IV: Arenes and Aromatic Electrophilic Substitution**

Aromatic electrophilic substitution—general pattern of mechanism, role of sigma and pi complexes. Mechanism of nitration, halogenations, Sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of Benzene derivatives. Birch reduction.

Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

#### **Books Recommended:**

1. Organic chemistry (vol.I)- S M Mukherji, S P Sing & R P Kapoor, New Age publishers, New Delhi.
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi
3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, New Delhi.
4. Organic chemistry, Morrison & Boyd, Pearson Education, New Delhi.

**B.Sc. (Hons.) Chemistry: Semester-II**  
**Physical Chemistry**  
**Paper No. - VI**

**Unit I: Solid State**

Crystalline and Amorphous Solid, Symmetry of Crystal Systems, Space Lattice and Unit Cell, Summary of Crystal Systems, Applications of Crystallographic Studies; Packing Fraction, Density of Crystalline Solid, Coordination Number, Number of Atoms in Unit Cell. Reciprocal Lattice and Law of Rational of Indices, Inter-planer Spacing in a Crystal System.

X-ray Diffraction, Bragg's Equation. Powder Method, Determination of Grain size/Crystallite size using X-ray Line Broadening Studies (Scherrer's Formula), The Rotating Crystal Method. Determination of Crystal Structure of NaCl and KCl (The Laue Method and Powder Method).

**Unit II: Colloidal State.**

Introduction and Definition of Colloids, Classification of Colloids.

Solids in Liquids (Sols): Preparation of Sols, Purification of Sols, Properties of Sols: Kinetic, Optical and Electrical Properties of Sols; Helmholtz and Stern Double Layer Concept, Zeta Potential, Stability of Colloids, Protective Action, Hardy-Schulze Law, Gold Number.

Liquids in Liquids (Emulsions): Types of Emulsions, Preparation and Properties of Emulsions. Emulsifier.

Liquids in Solids (Gels): Classification, Preparation and Properties.

General Applications of Colloids.

**Unit III: Chemical Kinetics-II**

Theories of Reaction Rates: Collision Theory of Reaction Rates, Arrhenius Equation, Absolute Reaction Rate Theory, Lindemann Theory of Unimolecular Reactions.

Simultaneous Reactions: Consecutive Reactions, Parallel Reactions, Reversible or Opposing Reactions.

**Books Recommended:**

1. Essentials of Physical Chemistry, B.S. Bahl, G.D.Tuli and Arun Bahl, S. Chand & Company Ltd.
2. A Text Book of Physical Chemistry, A.S. Negi and S.C. Anand, New Age International Publishers.
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.
4. Physical Chemistry through Problems, S. K. Dogra and S. Dogra Wiley Eastern Ltd.

**B.Sc.(Hons.) Chemistry: Semester II**  
**Inorganic Chemistry Practical**

**Qualitative Analysis:**

Semi micro qualitative analysis of inorganic salt mixtures containing:

**Anions:** (including interfering radical)

Sulphide, nitrite, oxalate, iodide and sulphate

**Cations:**

Group III cations: Aluminium, ferrous, ferric, chromium.

Group IV cations: Cobalt, nickel, manganese, zinc.

Group V cations: Barium, strontium, calcium

Group VI cations: Magnesium,

**Book suggested:**

1. Vogel's Text Book of Inorganic Qualitative Analysis, 4 th edition, ELBS, London, 1974. .
2. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd edition, The National Publishing Company, Chennai, 1974.

**B.Sc.(Hons.) Chemistry: Semester II**  
**Organic Chemistry Practical**

**Quantitative Analysis**

Determination of extra element (N, S & halogens). Identification of functional groups ---

Phenolic, Carboxylic, Carbonyl, esters, amines, amides & carbohydrates in simple organic compounds.

**B.Sc. (Hons.) Chemistry: Semester-II**  
**Physical Chemistry Practical**

**Chemical Kinetics**

1. To study the kinetics of the reaction between Iodide and persulphate by initial rate method.
2. To study the kinetics of the saponification of ethylacetate by integrated rate method.
3. Indexing of given powder diffraction pattern of a cubic crystalline system.
4. Use of computational tools to plot and analyze data.
5. Any other experiment(s) introduced during the year.

**Colloids**

1. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi- and trivalent ions.
2. Any other experiment(s) introduced during the year.

**Books Suggested**

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

**B. Sc. (Hons.) Chemistry: Semester - III**  
**Inorganic Chemistry**  
**Paper No. - VII**

**Unit I. Group II Elements**

Comparative study of these elements with special reference to their d-hydrides, oxides, hydroxide and halides. Diagonal relationship, salvation and complexation tendencies including their function in biosystems, and introductions to alkyls and aryls compounds.

**Unit II. Group III (13) Elements**

Comparative study of physical and chemical properties of these elements with special reference to their oxides, hydrides, halides and nitrides. Preparation and properties of boric acids (ortho & meta boric acids) and borax, borax bead test. Study of hydrides formed by boron, structure and bonding in diboranes, an idea of three center-two electron bond in the light of molecular orbital theory, borazine, borohydrides.

**Unit III. Group IV (14) Elements**

Comparative study of physical and chemical properties of these elements with special references to their oxides, hydrides, nitrides, sulphides and carbides, fluorocarbons, study of silicates (structural aspects only), silicones. allotropy, inert pair effect, metallic and non-metallic character, catenation and heterocatenation.

**Unit IV. Group V (15) Elements**

Comparative study of the physical and chemical properties of these elements with special reference to their hydrides, oxides, halides, oxyhalides and sulphides, Oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, hydrazoic acid, pernitric acid; oxoacids of phosphorus-orthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri-, and tetrapolyphosphoric acids;

**Books suggested:**

1. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson, and P.L.Gaus.
2. Concise Inorganic chemistry by J.D. Lee.
3. Inorganic Chemistry by G.L. Miessler and D.A. Tarr.
4. Inorganic Chemistry by A. G. Sharp.



**B.Sc. (Hons.) Chemistry: Semester - III**  
**Organic Chemistry**  
**Paper No. - VIII**

**Unit I: Haloalkanes and Haloarenes**

Nomenclature and classes of alkyl halides, methods of formation, Nucleophilic substitution in haloalkanes. Mechanisms of nucleophilic Substitution(  $S_N2$  and  $S_N1$ ) reactions with energy profile diagrams.  $\beta$ - Elimination, mechanisms of  $\beta$ -elimination. Experimental evidence for  $E_1$  and  $E_2$  mechanisms. Substitution versus elimination. Polyhalogen compounds: Chloroform, carbon tetrachloride.

Methods of formation of Haloarenes, Nucleophilic aromatic substitution Through addition elimination and the elimination addition mechanisms(Benzyne mechanisms)

**Unit II: Alcohols**

Classification and Nomenclature

Dihydric alcohols- Nomenclature, methods of formation, chemical reactions of vicinal glycols, eg: Oxidative cleavage using  $(Pb(OAc)_4)$  &  $HIO_4$  and pinacol-pinacolone rearrangement.

Trihydric alcohols- Nomenclature and methods of formation, chemical reactions of glycol.

**Unit III: Phenols**

Nomenclature, structure and bonding of phenols, Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenol. Electrophilic aromatic substitution, acylation and carboxylation, mechanism of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Reimer Tiemann reaction.

**Unit IV: Ethers and Epoxides**

**A.** Nomenclature of ethers and methods of their formation, Physical properties. Chemical reactions- Cleavage and autooxidation, Ziesel's method.

**B.** Synthesis of epoxides. Acids and base catalysed ring opening, reaction of Grignards and organolithium reagents with epoxides.

**Recommended Books**

1. Organic Chemistry(Vol. I)- S M Mukherji, S P Sing & R P Kapoor, New Age Publishers, New Delhi.
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .

3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, New Delhi.
4. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.
5. Understanding Organic Chemistry, Brown & Foote, Cengage Learning .

**B.Sc. (Hons.) Chemistry: Semester-III**  
**Physical Chemistry**  
**Paper No. - IX**

**Unit I. Thermodynamics – I:**

Definitions: system, surroundings, intensive and extensive properties, thermodynamic processes, state and path functions.

First law of thermodynamics: statement, internal energy, reversible work of expansion, heat change at constant volume and constant pressure, enthalpy, energy as a function of T and V, enthalpy as a function of T and P, Joule experiment, Joule- Thomson experiment and coefficient, heat capacities, relation between  $C_p$  and  $C_v$ , important thermodynamic relations, isothermal adiabatic expansion of ideal gas, calculation of  $\Delta E$ ,  $\Delta H$ ,  $q$ , and  $w$ , comparison of  $w_{rev}$  and  $w_{irrev}$ , Carnot theorem and Carnot cycle and its efficiency.

**Unit II. Thermochemistry:**

Exothermic and endothermic reactions, standard states, relation between heat of reaction at constant volume ( $q_v$ ) and at constant pressure ( $q_p$ ), laws of thermochemistry, enthalpy of formation, integral heat of solution and dilution, bond dissociation energy, bond energy and its calculation, Kirchhoff's equation

**Unit III. Thermodynamics - II:**

Spontaneous process, statements of second law of thermodynamics, concept of entropy, mathematical treatment, energy as a function of S and V, enthalpy as a function of S and P, entropy change for isolated systems, thermodynamic equation of states, entropy change in phase transitions, entropy change for reversible expansion of ideal gas, entropy change on heating or cooling of a substance, reversible adiabatic changes, entropy as a criteria of spontaneity and equilibrium, third law of thermodynamics, Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data.

**Books Suggested:**

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R. R. Mishra
2. Principles of Physical Chemistry, S. H. Maron and C. F. Prutton

**B.Sc. (Hons.) Chemistry: Semester - III**  
**Inorganic Chemistry Practical**

**VOLUMETRIC ANALYSIS**

1. To determine the strength of sodium carbonate and sodium bicarbonate in a solution (use of multiple indicator) using 0.1 N HCl.
2. To determine the percentage of ammonia in a sample of ammonium salt by indirect method using 0.1N- NaOH and 0.1N HCl.
3. To determine the strength of  $\text{BaCl}_2$  in the given solution provided 1N  $\text{Na}_2\text{CO}_3$  and using 0.1N HCl.
4. To determine the strength of a given solution of  $\text{KMnO}_4$  using 0.1N oxalic acid.
5. To determine the strength of a given solution of  $\text{FeSO}_4$  using 0.1N  $\text{KMnO}_4$ .
6. To determine the strength of ferrous and ferric ions in a solution constraining both, using 0.1  $\text{KMnO}_4$ .

**B.Sc.(Hons.) Chemistry: Semester - III**  
**Organic Chemistry Practical**

I. Laboratory Techniques

- (a) Thin layer chromatography: Determination of  $R_f$  values & identification of organic compounds.
  - (i) Separation of green leaf pigments.
  - (ii) Preparation of separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone using toluene and light petroleum (40:60).
- (b) Paper chromatography : determination of  $R_f$  values and identification of organic compounds.

Separation of mixture of phenylalanine and glycine, alanine and aspartic acid, leucine and glutamic acid. Using ninhydrin as spraying reagent.

II. Separation of mixture of D, L- alanine, glycine, and L- Leucin using n- butanol.

Acetic acid : water (4 : 1 : 5) and ninhydrin as spraying reagent.

- III. Separation of monosaccharides- a mixture of D-galactose and D-Fructose using n- butanol : acetone : water (4 : 5 : 1) aryl hydrogen phthalate as spraying reagent.

**B.Sc. (Hons.) Chemistry: Semester-III**  
**Physical Chemistry Practical**

**Thermochemistry**

1. To determine the solubility of benzoic acid at different temperatures and to determine  $\Delta H$  of the dissolution process.
2. To determine the enthalpy of neutralization of a weak acid / weak base versus strong base/ strong acid and determine the enthalpy of ionisation of the weak acid / weak base.
3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber Cycle.
4. To determine the enthalpy of hydration of  $\text{CuSO}_4$ .
5. Verification of Hess's law by utilizing the enthalpy of neutralization of (i)  $\text{HCl}$  (aq), (ii)  $\text{NaOH(s)} + \text{HCl(aq)}$ , and (iii) enthalpy of solution of  $\text{NaOH(s)}$  in water.
6. Determination of basicity/acidity of a polybasic acid / polyacidic base.
6. Any other experiment(s) introduced during the year.

**BOOKS SUGGESTED**

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

**B.Sc. (Hons.) Chemistry: Semester - IV**  
**Inorganic Chemistry**  
**Paper No. - X**

**Unit I. Group VI (16) Elements**

Comparative study of physical and chemical properties of these elements with special reference to their hydrides, oxides, halides and oxyhalides. Detailed study of oxyacids, peroxyacids and thio-oxyacids of sulphur (with special emphasis on their structure).

**Unit II. Group VII (17) Elements**

Comparative study of physical and chemical properties of these elements with special reference to their electron affinity, electronegativity, bond dissociation energy, oxidation number, oxidizing power, reactivity of the elements, hydrides, oxides and oxyacids.

**Unit III. Oxyacids and Compounds of Halogens**

Detailed study of oxyacids, hypohalous acid HOX, halous acid HXO<sub>2</sub>, halic oxide HXO<sub>3</sub>, perhalic acid HXO<sub>4</sub>, peroxyacids, strength of oxoacids.

Interhalogens, polyhalides ions (with special emphasis on their structures): ClF, ICl; ClF<sub>3</sub>, BrF<sub>3</sub>, IF<sub>3</sub>; ClF<sub>5</sub>, BrF<sub>5</sub>, IF<sub>5</sub>.

Pseudohalogens: cyanide, thiocyanate, and azide-structure and properties.

**Unit III. Zero Group-Noble Gases**

Position of zero group in the periodic table, history of discovery of noble gases isolation of noble gases, detailed study of the compounds of xenon with fluorine (with special emphasis on their structures and bonding), clathrates.

**Books suggested:**

1. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson & P.L. Gaus.
2. Concise Inorganic Chemistry by J.D. Lee.
3. Inorganic Chemistry by W.W. Porterfield.
4. Inorganic Chemistry by D.E. Shriver, P.W. Atkins and C.H. Longford.
5. Inorganic Chemistry by A.G. Sharpe.

**B.Sc. (Hons.) Chemistry: Semester – IV**  
**Organic Chemistry**  
**Paper No. - XI**

**Unit I: Aldehydes and Ketones**

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes from acid chlorides, synthesis of aldehydes and Ketones using 1,3- dithiones, synthesis of ketones from nitriles and from carboxylic acids. Physical properties, Mechanism of nucleophilic addition to Carbonyl compounds. Condensation with ammonia and its derivatives. Witting reaction, Mannich reaction.

Use of acetals as protective group. Oxidation of aldehydes and ketones , Baeyer- Villiger oxidation of ketones, Cannizaro reaction, Clemmenson & Wolff Kischner's reductions,  $\text{LiAlH}_4$  and  $\text{NaBH}_4$  reduction. Halogenation of enolizable ketones. An introduction of alpha, beta unsaturated aldehydes and ketones.

**Unit II: Enolate anions and enamines**

Formation and reaction of enolate anions : an overview, Aldol reaction, Claisen and Dickmann condensation, Acetoacetic ester synthesis and Malonic ester synthesis. Conjugate addition to  $\alpha,\beta$ -unsaturated carbonyl compounds.

**Unit III: Carboxylic acids.**

Nomenclature , structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation and reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Preparation and reactions of halocarboxylic acids, Malic, Tartaric and Citric acids.

**Unit IV: Organic Compounds of Nitrogen**

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitro arenes and their reduction in acidic, neutral and alkaline media. Picric acid.

Structure and nomenclature of amines, stereochemistry of amines, separation of a mixture of primary, Secondary and tertiary amines structural features effecting basicity of amines preparation of alkyl and arylamines by reduction of nitro compounds and nitriles, reductive amination of aldehydes and ketones compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction.

Reaction of amines, electrophilic aromatic substitution in aryl amines. Reactions of amines with nitrous acid , synthetic transformations of aryl diazonium salts, azo coupling.

**Books Suggested:**

1. Organic Chemistry(Vol. I)- S M Mukherji, S P Sing & R P Kapoor, New Age Publishers, New Delhi.
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, .
4. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.
5. Understanding Organic Chemistry, Brown & Foote, Cengage Learning



**B.Sc. (Hons.) Chemistry: Semester-IV**  
**Physical Chemistry**  
**PAPER - XII**

**Unit I: Free Energy Functions:**

Purpose of new functions, Helmholtz free energy,  $A$ , variation of  $A$  with  $T$  at constant  $V$ , Gibbs free energy,  $G$ , variation of  $G$  with  $P$  at constant  $T$ , relation between  $A$  and  $G$ , temperature-dependence of  $G$  (Gibbs – Helmholtz equation),  $\Delta A$  and  $\Delta G$  of the system and  $\Delta S$  of universe, criteria for equilibrium at constant  $T$  and  $V$ , and at constant  $T$  and  $P$ , spontaneity and relative values of  $\Delta H$  and  $T\Delta S$ , coupled reactions.

**Unit II: Electrochemistry- I:**

Electrical transport - conduction in metals and in electrolyte solutions, electrolysis, conductance of solutions (conductance,  $G$ , conductivity/specific conductance,  $\kappa$ ) equivalent and molar conductivities, measurement of conductance, variation of conductivity and molar conductivity with concentration, Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, Ostwald's dilution law, its uses and limitations, Debye – Huckel – Onsager equation for strong electrolytes (only introductory treatment), transport number, its determination by Hittorf and moving boundary methods, applications of conductivity measurements: determination of degree of dissociation,  $K_0$  of acids, solubility product of a sparingly soluble salt, conductometric titrations.

**Unit III: Electrochemistry – II:**

Electrolytic and Galvanic cells, reversible and irreversible cells, conventional representation of electrochemical cells, electromotive force and its measurement, electrical and electrochemical potentials, Nernst equation, types of half-cells and their reactions (gas-ion half cells, metal-metal ion half cells, metal- insoluble salt – anion half-cell, oxidation reduction half-cell, electrochemical series, calculation of cell e.m.f., thermodynamic quantities of cell reactions ( $\Delta G$ ,  $\Delta H$ , and  $\Delta S$ ), reference electrodes, glass electrode, calomel electrode, determination of equilibrium constant, determination of pH of a solution, potentiometric titration.

**Unit IV: Concentration cells:** Electrode concentration cells without transference, electrolyte concentration cells without transference, concentration cells with transference, liquid junction potential.

**Books Suggested:**

1. An Introduction to Chemical Thermodynamics, R.P.Rastogi and R.R. Mishra.
2. Principles of Physical Chemistry, S.H. Maron and C.F. Prutton.
3. A Textbook of Physical Chemistry, K.L.Kapoor, Vol. I and III.

**B.Sc. (Hons.) Chemistry: Semester - IV**  
**Inorganic Chemistry Practical**

**VOLUMETRIC ANALYSIS**

1. To determine the strength of hydrogen peroxide in aqueous solution using 0.1N  $\text{KMnO}_4$ .
2. To determine the strength of a given solution of ferrous ammonium sulphate using 0.1N  $\text{K}_2\text{Cr}_2\text{O}_7$ .
3. To standardize a given hypo solution with 0.1N  $\text{K}_2\text{Cr}_2\text{O}_7$ .
4. To determine the strength of a given solution of  $\text{CuSO}_4$  using 0.1N hypo solution.
5. To determine the percentage of available chlorine in bleaching powder using 0.1N hypo solution.
6. To determine the strength of given solution of  $\text{I}_2$  using arsenious oxide solution.

**B.Sc. (Hons.) Chemistry: Semester - IV**  
**Organic Chemistry Practical**

**Quantitative Analysis**

Identification of organic compounds through functional group analysis determination of melting point and preparation of a suitable derivatives.

**B.Sc. (Hons.) Chemistry: Semester - IV**  
**Physical Chemistry Practical**

**Potentiometry**

1. Preparation of saturated calomel electrode (SCE) or silver-silver chloride electrode.
2. Perform the following acid – base potentiometric titrations (at least two):
  - (i) Strong acid with Strong base,
  - (ii) Weak acid with strong base (also determine the  $\text{pK}_a$  value of the acid) and
  - (iii) Dibasic acid with strong base
3. To titrate potentiometrically the given ferrous ammonium sulphate (Mohr's salt) solution using  $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$  as titrant and calculate the redox potential of  $\text{Fe}^{2+} / \text{Fe}^{3+}$  system on the hydrogen scale.

### Conductance

1. To study changes in conductances during titration with strong alkali in the following systems:
  - (i) Strong acid
  - (ii) Weak acid, and
  - (i) Mixture of strong acid and weak acid
2. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
3. To study the saponification of ethyl acetate conductometrically.
4. To determine the ionization constant of a weak acid conductometrically
5. Any other experiment(s) introduced during the year.

### BOOKS SUGGESTED

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

**B. Sc. (Hons.) Chemistry: Semester - V**  
**Inorganic Chemistry - I**  
**Paper No. -XIII**

**Unit I. Chemistry of Elements of First Transition Series**

Characteristics of d-block elements with special reference to electronic configuration, oxidation states, variable valency, metallic character, colour, magnetic properties, catalytic properties and ability to form complexes, their binary compounds and complexes illustrating relative stability of their oxidation states, Coordination number and Geometry.

**Unit II. Chemistry of Elements of Second and Third Transition Series.**

General Characteristics, Comparative treatment with their 3d analogues in respect of ionic radii, Oxidation States, Magnetic behavior, Spectral properties and Stereochemistry. Comparison of the properties of second and third transition series with first transition series.

**Unit III. Coordination Compounds**

Introduction: ligands-monodentate, bidentate, and polydentate ligands; coordination sphere; coordination number; nomenclature of mononuclear and dinuclear complexes; chelate effect, Sidgwick theory-EAN and stability,

**Unit IV. Geometry and Structure of Coordination Compounds**

Isomerism: linkage-, ionization-, hydrate-, coordination-, coordination position isomerism, geometrical- (cis- and trans-, and fac- and mer-), optical isomerism.

Formation of metal-metal bond in dimers; valence bond theory-hybridization, geometry, magnetism, drawbacks of VBT

**Book suggested:**

1. Advanced Inorganic Chemistry - Cotton and Wilkinson
2. Concise Inorganic Chemistry - J.D.Lee
3. Modern approach to Inorganic chemistry – Bell and Lott
4. Theoretical Inorganic Chemistry – J.Huhey
5. Principles of Inorganic Chemistry – Emelns and Anderson

**B. Sc. (Hons.) Chemistry: Semester - V**  
**Inorganic Chemistry - II**  
**Paper No. - XIV**

**Unit I. Metal-Ligand Bonding in Transition Metal Complexes.**

Valence bond theory of transition metal complexes, Limitations of Valence Bond Theory, an elementary idea of crystal field theory, Crystal field theory, splitting of d-orbitals in octahedral, tetrahedral and square-planar complexes – low spin and high spin complexes, strong and weak field ligands, pairing energy, Jahn-Teller distortion,

**Unit II. Qualitative MO theory**

Concept of potential energy curves for bonding and antibonding molecular orbitals. Qualitative description of selection rules and Frank-Condon principle. Qualitative description of  $\sigma$ ,  $\pi$  and  $n$  MO, hybrid MO, their energy levels and the respective transitions.

**Unit III. Bio-Inorganic Chemistry**

Essential and Trace Elements in Biological Processes, Metalloporphyrins with special reference to Haemoglobin and Myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to  $\text{Na}^+$  and  $\text{Ca}^{++}$ .

**Unit IV. Environmental Chemistry**

**Chemical Toxicology**

Toxicity -effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, Co,  $\text{NO}_x$ ,  $\text{SO}_2$ ,  $\text{O}_3$ , PAN, CN, pesticides, carcinogenic substances.

**Books suggested:**

1. Concise Inorganic Chemistry by J.D. Lee.
2. Concepts and models of Inorganic Chemistry by B. Douglas, D. Mc Daniel and J. Alexander.
3. Inorganic Chemistry by W.L. Jolly.
4. Chemistry of Elements by N.N. Greenwood.
5. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L. Gaus.

**B.Sc. (Hons.) Chemistry: Semester – V**  
**Organic Chemistry - I**  
**Paper No. - XV**

**Unit I: Synthetic Dyes**

Colour and Constitution( electronic concept). Classification of dyes. Chemistry and synthesis of methyl orange, Congo red, Malachite, green crystal violet. Phenolphthalein, Fluorescein, Alizarin and indigo.

**Unit II: Carboxylic acids derivative**

Structure and nomenclature of acid chlorides, esters, amides, (urea) and acid anhydrides. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

**Unit III: Halonitroarenes:**

Reactivity Structure and nomenclature of amines, Physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Amine salts as phase transfer catalysis. Preparation of alkyl and aryl amines( reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction, Hofmann bromamide reaction.

Reactions of amines electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformation of aryl diazonium salt, azo coupling.

**Unit IV: Introduction to organometallic compounds:**

Organomagnesium and organolithium compounds, Lithium Diorganocopper(Gilman) reagents, Carbenes and carbenoids.

**Recommended Books:**

1. Organic Chemistry(Vol. I)- S M Mukherji, S P Sing & R P Kapoor, New Age Publishers, New Delhi.
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi.
3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, New Delhi.
4. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.
5. Understanding Organic Chemistry, Brown & Foote, Cengage Learning
6. Spectroscopy by Dyer.

**B.Sc. (Hons.) Chemistry: Semester – V**  
**Organic Chemistry - II**  
**Paper No. - XVI**

**Unit I Electromagnetic Spectrum**

Absorption spectra, Ultraviolet (UV) absorption spectroscopy- absorption laws (Beer Lamber Law) molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophores and auxochromes. Bathochromic, hypsochromic and hyperchromic shifts. UV spectra of conjugated enes and enones.

Infrared (IR) absorption spectroscopy- Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

**Unit II Organosulphur Compounds**

Nomenclature, structural features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine.

**Unit III Organic Synthesis via enolates**

Acidity of  $\alpha$  hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1,3 –dithianes. Alkylation and acylation of enamines.

**Unit IV Polynuclear Hydrocarbons**

Preparation and properties of naphthalene, anthracene and phenanthrene.

**Books suggested:**

1. Organic Chemistry by Mukherji, Singh & Kapoor, Vol. III
2. Organic Chemistry by Morrison and Boyd.
3. Organic Chemistry by I.L. Finar Vol. I and II
4. Organic Chemistry by P.Y. Bruice
5. Applications of Absorption Spectroscopy of Organic Compounds by J.R. Dyer
6. Organic Spectroscopy by W. Kemp.
7. Organic Spectroscopy by L.D.S. Yadav
8. Spectroscopic Identification of Organic Compounds by Silverstein, Bassler & Morrill.

**B.Sc. (Hons.) Chemistry: Semester-V**  
**Physical Chemistry – I**  
**(Quantum Chemistry)**  
**Paper No. - XVII**

**45 Lectures**

**Unit-I : Elementary Quantum Mechanics [20 L]**

Postulates of Quantum Mechanics, Hamiltonian operator, Schrödinger equation and its application to “particle – in – a – box”, Extension to three dimensional box, quantization of energy zero point energy and Heisenberg Uncertainty Principle, wave functions, probability distribution functions, degeneracy, Bohr’s Model of the hydrogen atom and its defects (no derivation).

**Unit-II : Angular Momentum [5 L]**

Orbital angular momentum, generalized angular momentum, quantization of the square of the orbital angular momentum and its z component.

**Unit-III : Atomic Structure and Chemical bonding [20 L]**

Schrödinger wave equation for H- atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave function and angular wave function. Molecular orbital theory basic ideas – criteria for forming M.O. from A.O., construction of M.O’s by LCAO –  $H_2^+$  ion.

**Books Recommended:**

1. Physical Chemistry by K. L. Kapoor., Macmillan India Ltd.
2. Introductory Quantum Chemistry by A.K. Chandra, Tata McGraw Hill.
3. Physical Chemistry by P. W. Atkins.



**B.Sc. (Hons.) Chemistry: Semester-V**  
**Physical Chemistry - II**  
**PAPER No. - XVIII**

**Unit I. Adsorption and Catalysis**

Adsorption and heat of adsorption, factors effecting adsorption, physical and chemical adsorption, types of adsorption isotherms, effect of catalyst on activation energy of a reaction, homogeneous and heterogeneous catalysis, promoters, inhibitors autocatalysis, enzyme catalysis, theories of catalysis. Mechanism and kinetics of enzymn and micellar catalysed reactions. Michaelis-Menten equation. Catalysis characteristics of catalyze reactions classification of catalysis, miscellaneous examples.

**Unit II. Solution and Colligative properties**

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoults law, relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure determination of molecular weight from osmotic pressure.

Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Abnormal molar mass, degree of dissociation and association of solutes.

**Unit III. Photochemistry**

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry, Grothus- Drapper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, quantum yield, photosensitized reactions – energy transfer processes. Kinetics of hydrogen-chlorine reaction.

**Books Suggested:**

1. Elements of Physical Chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
2. A Textbook of Physical Chemistry, K L Kapoor
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.

**B.Sc.(Hons.) Chemistry: Semester - V**  
**Inorganic Chemistry Practical**

**Gravimetric analysis**

1. Estimation of sulphate as barium sulphate.
2. Estimation of barium as barium chromate.
3. Estimation of copper as copper as copper thiocyanate.
4. Estimation of nickel as Ni-DMG.
5. Estimation of magnesium as magnesium pyrophosphate.
6. Estimation of calcium as calcium oxalate.

**Books suggested:**

1. Vogel's Textbook of Quantitative Inorganic Analysis (revised)
2. Experimental Inorganic Chemistry by W.G. Palmer.

**B.Sc. (Hons.) Chemistry: Semester-V**  
**Organic Chemistry Practical**

1. Lab Techniques

- (a) Steam distillation: (i) Naphthalene from its suspension in water.  
(ii) Clove oil from cloves. (iii) Separation of o- and p- nitrophenols.
- (b) Column chromatography
  - (i) Separation of fluorescein and methylene blue.
  - (ii) Resolution of racemic mixture of (+) mandelic acid.

**B.Sc. (Hons.) Chemistry: Semester - V**  
**Physical Chemistry Practical**

1. Adsorption of acetic acid / oxalic acid on charcoal.
2. Determination of molar mass of phenyl acetic acid by depression in freezing point method using benzene as solvent.
3. Determination of molar mass of a non-volatile solute by Rast method, Beckmann freezing point method.
4. To verify Beer-Lambert law for  $\text{KMnO}_4$  /  $\text{K}_2\text{Cr}_2\text{O}_7$  and determine the concentration of the given substance.
5. To determine the  $\text{pK}_a$  value of an indicator for phenolphthalein or methyl red colorimetrically.
6. To study the formation of a complex between ferric and salicylate ions colorimetrically and determine the composition of a complex by Job's method of continuous variations.
7. Study the kinetics of interaction of Crystal violet with sodium hydroxide colorimetrically.
8. To determine the specific rotation of a given optically active compound using Polarimeter.
8. Any other experiment(s) introduced during the year.

**BOOKS SUGGESTED**

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
2. 2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

**B. Sc. (Hons.) Chemistry: Semester - VI**  
**Inorganic Chemistry - I**  
**Paper No. - XIX**

**Unit I. Chemistry of Lanthanide Elements**

Chemistry of lanthanides – electronic structure, oxidation states, ionic radii, lanthanide contraction, consequences of lanthanide contraction, lanthanide compound, complex formation, magnetic properties, spectral properties and separation of lanthanides by ion exchange and solvent extraction methods

**Unit II. Chemistry of Actinides**

Electronic structure, oxidation states, ionic radii, actinide contraction, complex formation, chemistry of separation of Np, Pu and Am from U, comparison with lanthanides in terms of magnetic properties and spectral properties

**Unit III. Thermodynamics and Kinetics Aspects of Metal Complexes**

A brief outline thermodynamic stability of metal complexes and factors affecting the stability, high spin and low spin complexes, inner orbital and outer orbital complexes, high spin and low spin complexes, inner orbital and outer orbital complexes.

**Unit IV. Organometallic Compounds:**

Introduction – Definition, classification based on metal carbon bond, naming of organometallic compounds. Application of 18e- rule to predict M-M bond. metal-alkene complexes, metal-alkyne complexes, Preparation, properties, structure and bonding in ferrocene.

**Book Suggested:**

1. Cotton F. A., Wilkinson G., Murillo C. A., Bochmann M., Advanced Inorg. Chemistry, 6th edn., Pubs: John Wiley India. (2003).
2. Shriver D. F., Atkins F. W. and Langford C. M., Inorganic Chemistry, 3rd edn., Pubs: Oxford University Press, 1999.
3. Huheey J. E., Keiter E. A., Keiter R. L., Inorganic Chemistry : Principles of Structure and Reactivity; 4th edn, Pubs: Harper Collins, 1993.
4. Massey Allan G., Main Group Chemistry, Pubs: Ellis Horwood, New York 1990.
5. Elschenbroich C., Organometallics. Pubs: Wiley VCH Verlag GmbH (2005).

**B. Sc. (Hons.) Chemistry: Semester - VI**  
**Inorganic Chemistry - II**  
**Paper No. -XX**

**Unit IV. Hard and Soft Acids and Bases (HSAB)**

Bonding in hard-hard and soft-soft combination, HSAB principle, Applications of HSAB principle-Stability of complex, prediction of co-ordination in complex of ambident ligands, prediction of feasibility of reaction and prediction of hardness and softness.

**Unit V. Magnetic Properties of Transition Metal Complexes**

Types of magnetic behavior, methods of determining magnetic susceptibility, spin only formula, L-S coupling, correlation of  $\mu_s$  and  $\mu_{eff}$  values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

**Unit VI. Electron Spectra of Transition Metal Complexes**

Types of Electronic Transitions, Selection rules for d-d transitions, Spectroscopic ground states, Spectrochemical Series, Orgel-Energy level diagram for  $d^1$  to  $d^9$  states, discussion of the Electronic Spectrum of  $[Ti(H_2O)_6]^{3+}$  complex ion.

**Unit VI. Stereo-electronic effects in Transition metal complexes:**

Substitution in square planar complexes. The trans-effect, its synthetic application, I.D. theories of trans effects, Redox reactions., electron transfer reactions, mechanism of one electron transfer reactions, outer-sphere type reactions, inner sphere type reactions.

**Book Suggested:**

1. Concise Inorganic Chemistry by J.D. Lee.
2. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L. Gaus.
3. Concepts and Models of Inorganic Chemistry by B. Douglas, D. Mc Daniel and J. Alexander.
4. Physical Methods in Chemistry by R.S. Drago.

**B.Sc. (Hons.) Chemistry: Semester – VI**  
**Organic Chemistry - I**  
**Paper No. - XXI**

**Unit I: Amino acids, Peptides and Proteins and Nucleic acids**

Classification, structure and stereochemistry of amino acids. Acid-base behavior, isoelectric point and electrophoresis. Preparation and reaction of alpha amino acids. Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide Structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis. Structures of peptides and proteins. Levels of protein structure. Protein denaturation/renaturation

**Unit II: Nucleic acids**

Nucleic acids: Nucleosides and nucleotides, The structure of DNA. Ribonucleic acids. The Genetic code. Sequencing nucleic acids.

**Unit III: Fats, Oils and Detergents**

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value, acid value, soaps, synthetic detergents, alkyl and aryl sulphonates.

**Unit IV: Synthetic polymers**

Architecture of polymers. Polymer notation and nomenclature. Molecular weights of polymer. Polymer morphology-Crystalline versus amorphous materials. Addition or chain growth polymerization. Free radical Polymerization, ionic vinyl polymerization, Ziegler Natta Polymerization and vinyl Polymers.

Condensation or step growth polymerization. Polysters, Polyamides, phenol formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.

**Recommended Books**

1. Organic Chemistry (Vol. I)- S M Mukherji, S P Sing & R P Kapoor, New Age Publishers, New Delhi.
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, New Delhi.
4. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi, Understanding Organic Chemistry, Brown & Foote, Cengage Learning

**B.Sc. (Hons.) Chemistry: Semester – VI**  
**Organic Chemistry - II**  
**Paper No. - XXII**

**Unit I: Spectroscopy**

Nuclear Magnetic Resonance (NMR) spectroscopy. Proton magnetic resonance ( $^1\text{H}$  NMR) spectroscopy. Nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,2-tribromoethane, ethyl acetate, toluene and acetophenone, Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

**Unit II: Heterocyclic Compounds**

Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.

**Unit III: Carbohydrates**

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethyl and esters. Determination of ring size of monosaccharides. Cyclic structure of D (+) glucose. Mechanism of mutarotation. Structures of ribose and deoxyribose. An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

**Unit IV: Reaction Mechanism**

Pinacol-Pinacolone Rearrangement, Benzil Benzylic acid Rearrangement, Hoffmann Rearrangement, Lossen Rearrangement, Curtius Rearrangement, Schmidt Rearrangement

**Books suggested:**

1. Organic Chemistry by Morrison and Boyd.
2. Organic Chemistry by I.L. Finar Vol. I and II
3. Organic Chemistry by P.Y. Bruice
4. Applications of Absorption Spectroscopy of Organic Compounds by J.R. Dyer
5. Organic Spectroscopy by W. Kemp.
6. Organic Spectroscopy by L.D.S. Yadav
7. Spectroscopic Identification of Organic Compounds by Silverstein, Bassler & Morrill.
8. Heterocyclic Chemistry by R.R. Gupta, M. Kumar & V. Gupta, Vol. II
9. Heterocyclic Chemistry by T.L. Gilchrist
10. A Guidebook to Mechanisms in Organic Chemistry by Peter Sykes.

**B.Sc. (Hons.) Chemistry: Semester-VI**  
**Physical Chemistry – I**  
**(Spectroscopy)**  
**Paper No. - XXIII**

**45 Lectures**

**Unit I: Introduction**

**[5 L]**

Electromagnetic radiation, regions of the spectrum, Statement of the Born Oppenheimer Approximation.

**Unit II: Rotational, Vibrational and Raman Spectrum**

**[18 L]**

Diatomic molecules: Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell Boltzmann distribution), determination of bond length, qualitative description of non-rigid rotor, isotopic substitution.

**Infrared spectrum:** Classical equation of vibration, energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotopic substitution, Degrees of freedom of polyatomic molecules, modes of vibration (e.g. H<sub>2</sub>O & CO<sub>2</sub>) Concept of group frequencies.

**Raman spectrum:** Qualitative treatment of Pure Rotational and Pure Vibrational Raman spectra of diatomic molecules, Stokes and Anti-Stokes lines, their intensity difference, rule of Mutual Exclusion.

**Unit III: Electronic Spectrum**

**[7 L]**

Franck Condon Principle, Electronic Transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

**Unit IV: Nuclear Magnetic Resonance (NMR) and Electron Spin Resonance (ESR) Spectra**

**[15 L]**

Principles of NMR spectroscopy, chemical shifts, spin-spin splittings, Relaxation time, Principle of ESR spectroscopy, hyper fine spectra and ESR spectrum of Benzene Anion radical.

**Books recommended:**

1. Physical Chemistry by K. L. Kapoor., Macmillan India Ltd.
2. **Fundamentals of Molecular Spectroscopy by C.N. Banwell & E.M. McCash, Tata McGraw Hill.**



**B.Sc. (Hons.) Chemistry: Semester-VI**  
**Physical Chemistry - II**  
**PAPER No. - XXIV**

**Unit I. Phase Equilibrium**

Statement and meaning of the terms – phase component and degree of freedom , derivation of Gibbs phase rule, phase equilibria of one component system – water, CO<sub>2</sub> and S systems.

Phase equilibria of two component system – solid liquid equilibriums, simple eutectic

Bi-Cd and Pb-Ag system.

Solid solutions – compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (NaCl-H<sub>2</sub>O) FeCl<sub>3</sub>-H<sub>2</sub>O) and (CuSO<sub>4</sub>-H<sub>2</sub>O) system,

Liquid- liquid mixtures – ideal liquid mixtures, Raoult's and Henry's law. Non – ideal system azeotropes (HCl-H<sub>2</sub>O) and ethanol- water systems.

**Unit II. Chemical equilibria**

Formulation of equilibrium law, equilibrium law for ideal gases, interpretation of  $\Delta G^0$ , free energy change in a chemical reaction, chemical affinity and thermodynamic functions, equilibrium constants for ideal gas reactions, relation between K<sub>p</sub> and K<sub>c</sub> and K<sub>x</sub>, change of K with the form of equation, calculation of K from  $\Delta G^0$ , variation of equilibrium constant with temperature and pressure, effect of inert gas on reaction equilibrium, Le – Chatelier's principle, free energy of mixing and spontaneity of reactions, equilibria between gases and solids, equilibrium constant for a system of real gases, equilibrium constant of reactions in solution.

**Unit III. Ionic equilibria**

Acids and Bases Arrhenius concept, Proton transfer theory, Lewis concept.

Dissociation constants of weak acids and weak bases. Ionic product of water. The pH scale, Buffer solutions Calculations of pH values of buffer mixtures, Henderson equation.

Hydrolysis of salts, Hydrolysis constant, Relation between K<sub>h</sub>, K<sub>a</sub> and K<sub>b</sub>. Degree of hydrolysis. Solubility product Applications of solubility product principle.

**Books Suggested:**

1. Elements of Physical Chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
2. A Textbook of Physical Chemistry, K L Kapoor
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.

**B.Sc. (Hons.) Chemistry: Semester - VI**  
**Inorganic Chemistry Practical**

**SYNTHESIS AND ANALYSIS**

1. **Synthesis of following complexes**
  - a) Preparation of Ni DMG Complex  $[\text{Ni}(\text{DMG})]$ .
  - b) Preparation of Cis and Trans potassium bisoxalatodiaquachromate(III).
  - c) Preparation of coppertetraammine complex,  $[\text{Cu}(\text{NH}_3)_4\text{SO}_4]$ .
  - d) Preparation of Copper(I)tetraiodomercurate(II)- determination of the transition temperature between red and black forms by melting point apparatus.
2. **Instrumental Analysis**
  - a) Composition of iron(III)Salicylic acid complex ion in solution by job's method.
  - b) Adultration-Food Stuffs
3. **Water analysis**- pH, alkalinity, dissolved oxygen available chlorine, Hardness of water.
4. Estimation of nitrogen in the fertilizer.
5. Estimation of phosphate in a superphosphate sample.
6. Any other experiment introduce time to time

**B.Sc. (Hons.) Chemistry: Semester-VI**  
**Organic Chemistry Practical**

1. Quantitative Analysis:
  - (i) Analysis of an organic mixture containing two solid components using water,  $\text{NaHCO}_3$ ,  $\text{NaOH}$  for separation and preparation of suitable derivatives.
2. Synthesis of Organic Compounds
  - (i) Acetylation of aniline, salicylic acid & glucose.
  - (ii) Benzoylation of aniline phenol.
  - (iii) Aliphatic electrophilic substitution : Preparation of iodoform from acetone & ethanol.
  - (iv) Aliphatic electrophilic substitution : nitration (Preparation of m-dinitrobenzene & nitroacetanilide).  
Halogenation (Preparation of p-bromoacetanilide & 2, 4, 6- tribromophenol).
  - (v) Diazotization / coupling : Preparation of methyl orange & methyl red.
  - (vi) Oxidation : Preparation of benzoic from toluene.
  - (vii) Reduction : Preparation of aniline from nitrobenzene.

**B.Sc. (Hons.) Chemistry: Semester-VI**  
**Physical Chemistry Practical**

**Phase Equilibrium**

1. Determination of partition coefficient of iodine between water and carbon tetrachloride or toluene or chloroform.
2. Determination of partition coefficient of Benzoic acid between water and toluene.
3. Study the equilibrium of at least one of the following reactions by distribution method:
  - (i)  $\text{I}_2(\text{aq}) + \text{I}^-(\text{aq}) \rightleftharpoons \text{I}_3^-(\text{aq})$
  - (ii)  $\text{Cu}^{2+}(\text{aq}) + n\text{NH}_3(\text{aq}) \rightleftharpoons [\text{Cu}(\text{NH}_3)_n]^{2+}(\text{aq})$
4. To construct the phase diagram of two component (e.g. diphenyl amine – benzophenone, Naphthalene-Benzoic Acid)) system by cooling curve method.
5. To Study the effect of a solute (e.g. NaCl, Succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system.
6. Determination of the transition temperature of the given substance by thermometric / dilatometric method (e.g.  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ ,  $\text{Na}_2\text{SO}_4$ ,  $\text{SrSO}_4$ ,  $\text{Na}_2\text{CO}_3$ ).
7. Any other experiment(s) introduced during the year.

**BOOKS SUGGESTED**

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

**B.Sc.(Hons.) Chemistry Course Structure**

<b>B. Sc. (Hons.) Chemistry: Semester - I .....</b>	<b>1</b>
Inorganic Chemistry (Paper No. – I) .....	1
Organic Chemistry (Paper No. – II).....	3
Physical Chemistry (Paper No. – III).....	5
Chemistry Practical.....	6
 <b>B. Sc. (Hons.) Chemistry: Semester - II.....</b>	 <b>9</b>
Inorganic Chemistry (Paper No. –IV).....	9
Organic Chemistry (Paper No. – V) .....	11
Physical Chemistry (Paper No. – VI) .....	13
Chemistry Practical.....	14
 <b>B. Sc. (Hons.) Chemistry: Semester - III .....</b>	 <b>16</b>
Inorganic Chemistry (Paper No. – VII) .....	16
Organic Chemistry (Paper No. – VIII) .....	17
Physical Chemistry (Paper No. – IX) .....	19
Chemistry Practical.....	20
 <b>B.Sc. (Hons.) Chemistry: Semester - IV.....</b>	 <b>22</b>
Inorganic Chemistry (Paper No. – X) .....	22
Organic Chemistry (Paper No. – XI) .....	23
Physical Chemistry (PAPER – XII).....	25
Chemistry Practical.....	26
 <b>B. Sc. (Hons.) Chemistry: Semester - V .....</b>	 <b>28</b>
Inorganic Chemistry – I (Paper No. – XIII).....	28
Inorganic Chemistry – II (Paper No. – XIV) .....	29
Organic Chemistry – I (Paper No. – XV) .....	30
Organic Chemistry – II (Paper No. – XVI) .....	31

**DEPARTMENT OF CHEMISTRY, JAMIA MILLIA ISLAMIA, NEW DELHI - 110025**

**B.Sc.(Hons.) Chemistry Syllabus w.e.f. 2012-2013**

---

Physical Chemistry – I (Quantum Chemistry, Paper No. – XVII) .....	32
Physical Chemistry – II (PAPER No. – XVIII).....	33
Inorganic Chemistry Practical .....	34
Organic Chemistry Practical .....	34
Physical Chemistry Practical .....	35
 <b>B. Sc. (Hons.) Chemistry: Semester - VI.....</b>	 <b>36</b>
Inorganic Chemistry – I (Paper No. – XIX) .....	36
Inorganic Chemistry – II (Paper No. –XX) .....	37
Organic Chemistry – I (Paper No. – XXI).....	38
Organic Chemistry – II (Paper No. - XXII).....	39
Physical Chemistry – I (Spectroscopy, Paper No. – XXIII) .....	40
Physical Chemistry – II (Paper No. – XXIV) .....	41
Inorganic Chemistry Practical .....	42
Organic Chemistry Practical .....	43
Physical Chemistry Practical .....	44