Department of Chemistry
University of Lucknow
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B.Sc. Syllabus

Inorganic Chemistry

Semester I **Paper – 1** **Max Marks: 100 (80 + 20)**

UNIT I

I. Atomic Structure: Quantum mechanics based structure of atom in brief, shapes of s, p and d orbitals, aufbau and Pauli exclusion principles, Hund's Multiplicity rules. Electronic configurations of the elements, effective nuclear charge.

II. Periodic Properties and Classification based upon electronic configuration: Diagonalrelationship, inert pair effect, atomic and ionic radii, van der waal radii, ionizationenergy,

III. Electron affinity and electronegativity : definition, method of determination, trends in periodic table and applications in predicting and explaining chemical behaviour.

UNIT II

IV. Chemical Bonding

(a) Covalent bond: valence bond theory and its limitations, directional characteristic of covalent bond. Hybridization and shapes of simple molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to simple molecules and ions. Molecular Orbital theory for homonuclearand heteronuclear (CO and NO) diatomic molecules, multi-center bonding in electron deficient molecules, bond strength and the bond energy, % ionic character from dipole moment and electro
negativity difference.

(b) Weak interactions: hydrogen bonding, van der Waals forces.

UNIT III

V. Ionic solid: ionic structures, radius ratio effect and coordination number, limitation of ratio rule, Lattice defects, Lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions. Fajan's rule, Metallic bond free electron, Valence bond and Band theories.

VI. s-Block elements: Comparative study, salient features of hydrides, salvation and complexation tendencies of cations of alkali and alkaline earth matter including their function in biosystems, an introduction to alkyls and aryls of Li & Mg.

VII. Noble Gases: Chemical properties of the noble gases, discovery of $O_2^+PtF_6\dot{E}$ and O_2XeF_6.Chemistry of xenon, structure and bonding in xenon compounds.

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Inorganic Chemistry

Semester I **Paper – 1** **Max Marks: 100 (80 + 20)**

UNIT IV

VIII. p-Block Elements:- Comparative study (including diagonal relationship) physical and chemical behaviour of group 13-17 elements, compounds like hydrides, oxides, oxyacids and halides ofgroup 13-16, diborane, boronitride Ŭ, ɓ forms, Fullerenes, silicates(structural principle) andstructures of oxides and oxyacids of phosphorus and sulphur, interhalogens and polyhalides.

Text Books (Theory Courses):

(a) Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
(b) Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
(c) Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
(d) Chemistry for degree students, R. L. Madan

Reference Books:

(a) Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
(b) Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
(c) Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
(d) Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
(e) Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
(f) Inorganic Chemistry, A.G. Sharpe, ELBS
(g) Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

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Organic Chemistry

Semester I **Paper – 2** **Max Marks: 100 (80 + 20)**

UNIT I

I. Structure and bonding: Hybridization, bond lengths, bond angles, bond energy, localised and delocalized ´ bonds, resonance, inductive and field effects, hydrogen bonding, inclusion compounds, clathrates, charge transfer complexes, van der Waals interaction, hyperconjugation, aromaticity.

II. Mechanism of Organic Reactions: Curved arrow notation, drawing electron movements with arrows, half headed and double-headed arrows, homolytic and heterolytic bond breaking Reactive intermediates-generation, structure, stability and reactions of carbocation, carbanion, free radicals and carbenes, Arynes, Nitrenes.

III. Types of organic reactions-addition, elimination, substitution, rearrangement, condensation, methods of determination of reaction mechanism (product analysis, intermediates, isotopic effects, kinetic and stereochemical studies). Energy considerations.

UNIT II

IV. Stereoisomerism

Optical isomerism: Elements of symmetry, molecular chirality, optical activity, stereogenic centres, enantiomers, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. Relative and absolute configurations. Sequence rules. D, L and R, S nomenclature.

Geometrical isomerism: determination of configuration of geometric isomers. E, Z system, geometrical isomerism in oximes and alicyclic compounds. Conformatioal isomerism-Conformational analysis of ethane and n-butane and cyclohexane, axial and equatorial bonds, Saw-horse and flying wedge formulae, Fischer and Newman projections formulae. Difference between conformation and configuration.

UNIT – III

V. Alkanes And Cycloalkanes: Methods of formation with special reference to Wurtz, Kolbe, Corey-House reactions and decarboxylation. Physical properties and chemical reactions. Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes: Nomenclature, methods of preparation. Baeyer's strain theory and its limitations. Ring strain in (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring and banana bond.

VI. Alkenes, Cycloalkenes, Dienes: methods of formation. Mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. Regio-selectivity in alcohol-dehydration. Saytzeff's rule, Hofmann elimination.

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Organic Chemistry

Semester I **Paper – 2** **Max Marks: 100 (80 + 20)**

Physical properties and relative stabilities of alkenes. Chemical reactions of alkenes- Mechanisms involved in hydrogenation, electrophilic and free-radical additions. Markownikoffôs rule. Hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis, hydrations, hydroxylation and oxidation with $KMnO_4$, polymerization of alkenes. Substitutions at allylic and vinylic positions of alkenes.

Methods of formation, conformation and chemical resections of cycloalkenes.

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes, Structure of allenes and butadiene, methods of formation, chemical reaction ï 1, 2 and 1, 4 additions, Diels-Alder reaction.

VII. Alkynes: Structure and bonding in alkynes. Methods of formation, chemical reactions and acidity of alkynes. Mechanism of electrophilic and mucleophilic addition reactions, hydroboration-oxidation, reductions and oxidation reactions.

UNIT IV

VIII. Arenes and Aromaticity: Nomenclature of benzene derivatives. Structure of benzene: molecular formula and Kekule structure. Stability and carbon carbon bond length of benzene, resonance structure, MO picture.

IX. Aromatic electrophilic substitution- general pattern of the mechanism, Arrhenium ion intermediate. Mechanism of nitration, halogenation, sulfonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activation and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

X. Alkyl and Aryl Halides: Methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams, chloroform. Aryl halides - Methods of formation, nuclear and side chain reactions. Mechanisms of nucleophilic aromatic substitutions. Synthesis and uses of DDT, BHC.

Text Books (Theory Courses):

a. Organic Chemistry, Vol. I, I.L. Finar, Pearson Education.
b. Organic Chemistry, M.K. Jain, Shoban Lal& Co.
c. Pradeep's Organic Chemistry, S.N. Dhawan, Pradeep Publication.

Reference Books:

a. Organic Chemistry, Morrison and Boyd, Prentice Hall.
b. Organic Chemistry, L.G. Wade Jr. Prentice Hall.
c. Fundamentals of Organic Chemistry Solomons, John Wiley.
d. Organic Chemistry, Vol. I, II, III S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International)
e. Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
f. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.

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Physical Chemistry

Semester II **Paper 3** **Max Marks: 100 (80 + 20)**

UNIT I

I. Mathematical Concepts: Logarithmic relations, curves scratching, equation of straight line and slopes, tracing of curves, differentiation of simple functions like x, ex, xn, sinx, logx; maxima and minima, partial differentiation. Integration of some useful/relevant functions; Permutations and Combinations. Factorials, Probability.

II. Computers: General introduction to computers, different components of a computer. Hardware and Software, input-output devices, binary numbers and its arithmetic; introduction to computer languages, Programming and operating systems.

UNIT II

III. Gaseous State: Deviation of gases from ideal behaviour, van der Waals equation of State.

IV. Critical phenomenon: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equations, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of states.

V. Molecular Velocities: Qualitative discussion of the Maxwell's distribution of molecular velocities, collision numbers, mean free path and collision diameter. Liquification of gases (based on Joule Thomson effect).

VI. Liquid State: A qualitative description of intermolecular forces, structure of liquids,structural differences between solids, liquids and gases.

VII. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic, smectic and cholestric liquid crystals. Thermography and seven segment cell.

UNIT III

VIII. Solid State: Definition of unit cell and space lattice.

IX. Laws of crystallography:

a. Law of constancy of interfacial angles

b. Law of rationality of indices

c. Symmetry elements in crystals and law of symmetry.

X. Diffraction-X-ray diffraction by crystals. Derivation of Bragg's equation. Laueôs method and powder method, determination of crystal structure of NaCl, KCl and CsCl

XI. Colloidal State: Solids in liquids (sols): properties- Kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulz law, gold number.

XII. Liquids in liquids (emulsions): types of emulsions, preparation. Emulsifier.

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Physical Chemistry

Semester II **Paper 3** **Max Marks: 100 (80 + 20)**

XIII. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.

UNIT IV

XIV. Chemical Kinetics:

a. Molecularity and order of reaction, concentration dependence of rates, integrated rate expression for- zero order, first order, second order, pseudo order reactions, half-life.

b. Determination of the order of reaction: Differential method, method of integration, half-life method and isolation method.

c. Brief outlines of experimental methods of studying chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometery.

d. Theories of chemical kinetics: Arrhenius theory of reaction rate, effect of temperature on rate of reaction, concept of activation energy. Simple collision theory based on hard sphere model, transition state theory (equilibrium hypothesis).Thermodynamics aspect of transition state theory.

XV. Catalysis: Catalysis, classification of catalysis, characteristics of catalysed reactions,

Text Books (Theory Courses):

a. Physical Chemistry, Puri Sharma & Pathania.
b. Pradeep Physical Chemistry, Khetrapal, Pradeep Publication.
c. Computers and Common Sense, R. Hunt and Shelly, Prentice Hall.

Reference Books:

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGrawHill
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
e. Basic Programming with Application, V.K. Jain, Tata McGraw Hill.
f. Physical Chemistry, Glasstone

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Chemistry

Semester II **Practical** **Max Marks: 100**

Inorganic

I. Qualitative Analyses:

a. Identification of cations and anions in a mixture of inorganic compounds soluble in water/dilute acids (Macro/semi-micro analysis- cation analysis, separation of ions from group 0-VI, anion analysis). Only six radicals.

II. Quantitative Analysis:

a. *Volumetric Analysis*

i. Determination of acetic acid in commercial vinegar using NaOH

ii. Determination of alkali content - antacid tablet using HCl.

iii. Estimation of calcium content in chalk as calcium oxalate by permanganometry

iv. Estimation of hardness of water by EDTA

v. Estimation of ferrous ions by dichromate method

vi. Estimation of copper using thiosulphate.

b. *Gravimetric Analysis*

i. Ba as $BaSO_4$ in the given solution of $BaCl_2$

ii. Analysis of Cu as CuSCN

iii. Analysis of Ni as $Ni(DMG)_2$

Record & Viva

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Physical Chemistry

Semester III **Paper 4** **Max Marks: 100 (80 + 20)**

UNIT I

I. Thermodynamics-1

a. Definition of thermodynamic terms: System, surroundings etc. Types of systems, intensive andextensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

b. First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law - Joule-Thomson coefficient and inversion temperature. Calculation of w,q, dU&dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

II. Thermochemistry: Standard state, standard enthalpy of formation - Hess's Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy,effect of temperature on enthalpy of reaction, Kirchhoff s equation.

UNIT II

III. Thermodynamics - II

a. Second law of thermodynamics: statements of second law of thermodynamics, Carnot's cycle and its efficiency, Carnot's theorem. Thermodynamic scale of temperature, Le Chatelierôs principle, reaction isotherm and reaction isochore, Clapeyron-Clausius equation and its applications

b. Concept of entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, criteria of spontaneity and equilibrium change in ideal gases and mixing of gases.

IV. Gibbs and Helmholtz free energy functions and their definitions

UNIT III

V. Electrochemistry -1:

a. Electrical transport - Conduction in metals and in electrolyte solutions, specific conductance, equivalent conductance, experimental determination of equivalent conductance and specific conductance, variation of equivalent and specific conductance with dilution. Kohlrausch's law, weak and strong electrolyte, Arrhenius theory of electrolyte dissociation and its limitations. Ostwald's dilution law its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and its determination by Hittorfs method and moving boundary method.

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Physical Chemistry

Semester III **Paper 4** **Max Marks: 100 (80 + 20)**

VI. Applications of conductivity measurements: Determination of degree of dissociation, determination of Ka of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

UNIT IV

VII. Electrochemistry - II:

a. Types of reversible electrodes- Gas-metal ion, metal-ion, metal-insoluble salt-anion and redox electrodes. Electrode reactions, single electrode potential, standard electrode potential. Reference electrode: standard hydrogen electrode and calomel electrode, Nernst equation, derivation of cell E.M.F., electrochemical series and its significance.

b. Electrolytic and Galvanic cells- Reversible and irreversible cells, conventional representation of electrochemical cells.

c. EMF of a cell and its measurements- Calculation of cell EMF. Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and K)

d. Concentration cell with and without transport, liquid junction potential, application of concentration cells, valency of ions, solubility product and activity coefficient, potentiometric titrations.

VIII. Definition of pH and pKa, determination of pH using quinhydrone and glass electrodes by potentiometric methods. Buffers - Mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts.

Books Suggested (Theory Courses)

a. Physical Chemistry. G.M. Barrow. International Student Edition, McGraw Hill.
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry Through problems, S.K. Dogra and S. Dogra, Wiley Eastern Ltd.
e. Graduate physical Chemistry,VolumeI-III By L.R.sharma and M.s..Pathania
f. Principles of Physical Chemistry by B.R.Puri,L.P Sharma and M.S.Pathania,V ishal publication ,Jallandhar.

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Chemistry

Semester III **Practical** **Max Marks: 100**

Physical Chemistry

1. Chemical Kinetics
    a. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. Distribution Law
    a. To study the distribution of iodine between water and CCI4.
3. Colloids
    a. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi- and trivalent anions.
4. Viscosity, Surface Tension
    a. To determine the percentage composition of a given binary mixture (non interacting systems) by viscosity method.
    b. To determine the percentage composition of a given binary mixture (non interacting systems) by surface tension method (acetone & ethyl methyl ketone).
5. Phase Equilibrium
    a. To construct the phase diagram of two component (e.g. diphenylamine benzophenone) system by cooling curve method.
6. Thermochemistry
    a. To determine the solubility of benzoic acid at different temperatures and to determine æH of the dissolution process.
    b. To determine the enthalpy of neutralisation of a week acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.

Organic Chemistry

a. Sublimation
b. Crystallization
c. Identification of organic compounds with derivatives (solid compounds of all functional groups and liquid compounds.

Record and Viva

Books Recommended

(a) Chemistry Practical by S.Giri, D.N. Bajpai and O.P.Shukla,S.Chand Publication.
(b) Practical Chemistry Volume 1-3 by Fateh Bahadur, Vishal Publication
(c) Advanced Physical Chemistry by J.B.Yadav, Goel Publication

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Inorganic Chemistry

Semester IV **Paper 5** **Max Marks: 100 (80 + 20)**

UNIT I

I. Chemistry of Elements of First Transition Series: Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.

II. Chemistry of Elements of Second and Third Transition series: General characteristics, comparative treatment of Zr/Hf, Nb/Ta , Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

Unit - II

III. Coordination Compounds and double salts: Werner's coordination theory and its experimental verification, Sidgwickôs concept of effective atomic number, EAN concept, Polydentate ligands or chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes, Inner and outer orbital complexes, Limitations of VBT.

UNIT III

IV. Chemistry of Lanthanide Elements: Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, cerie ammonium sulphate and its analytical uses.

V. Chemistry of Actinides: Electronic conformation, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

Unit IV

VI. Oxidation and Reduction: Electrode potential, electrochemical series and its applications. Principles involved in the extraction of the elements.

VII. Acids and Bases : Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concept of acids and bases.

VIII. Non-aqueous Solvents: Physical properties of a solvent, types of solvents and their generalcharacteristics, Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.

Text Books (Theory Courses):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

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Semester IV **Paper 5** **Max Marks: 100 (80 + 20)**

Reference Books:

a. Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

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Organic Chemistry

Semester IV **Paper 6** **Max Marks: 100 (80 + 20)**

UNIT I

I. Alcohols:

Monohydric alcohols - Methods of formation by reduction of aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature,Reactions of alcohols.

Dihydric alcohols - Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacole-pinacolone rearrangement.

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

II. Ethers and Epoxides: Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions - cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening by Grignard and organolithium reagents.

UNIT II

III. Phenols:- Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols - electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

IV. Aldehydes and Ketones: synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldedydes and ketones using 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids. Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group, Oxidation of aldehydes, Baeyer-Viliiger oxidation of Ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, $LiAlH_4$ and NaBH4 reductions. Halogenation of enolizable ketones. An introduction to Ŭ,ƀ-unsaturated aldehydes and ketones.

UNIT III

V. Carboxylic Acids: physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, Reactions of carboxylic acids, Hell-Volhard-Zelinsky reaction, Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of halo acids,

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Semester IV **Paper 6** **Max Marks: 100 (80 + 20)**

VI. Hydroxy acids: Preparation and reactions. Methods of formation and chemical reactions of unsaturated monocarboxylic acids. Dicarboxylic acids: Methods of formation and effect of heat and dehydrating agents.

VII. Carboxylic Acid Derivatives: 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. Preparation of carboxylic acid derivatives, chemical reactions. Mechanisms of esterification and hydrolysis (acidic and basic).

UNIT IV

VIII. Organic Compounds of Nitrogen: Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media.

IX. Amines: Preparation, physical properties, stereochemistry of amines. Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydicand ketonic compounds. Gabriel -phthalimide reaction, Hoffmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling.

Books Suggested (Theory Courses)

a. Organic Chemistry, Morrison and Boyd, Prentice Hall.
b. Organic Chemistry, L.G. Wade Jr. Prentice Hall
c. Fundamentals of Organic Chemistry Solomons, John Wiley.
d. Organic Chemistry, Vol. I, II, III, S.M. Mukherji, S.P. Singh and R.P. Kapoor, Wiley Eastern Ltd. (New Age International).
e. Organic Chemistry, F.A. Carey, McGraw-Hill Inc.
f. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
g. Organic Chemistry, Vol. I, II, I.L. Finar
h. Spectrometric Identification of organic compounds. Robert M. Silverstein, Clayton G. Bassler, Terence C. Morril, John Wiley.

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Organic Chemistry

Semester V **Paper 7** **Max Marks: 100 (80 + 20)**

UNIT I

I. Organometallic Compounds: Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds; formation and chemical reactions. Organolithium compound formation and chemical reactions.

II. Organosulphur compounds: Nomenclature, structural, features, methods of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidene.

III. Heterocyclic compounds

Introduction: Molecular orbital picture and aromatic characteristic of pyrrole, furan, thiophene and pyridine, methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, mechanism of nucleophilic substitution reaction in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole.Introduction to condensed five and six membered heterocycles. Preparation and reactions of indols, quinoline and isoquinoline with special reference to Fisher Indols synthesis, Skraup synthesis and Bischler ï Nepieralski synthesis. Mechanism of electrophilic substitution reaction of indole, quinoline and isoquinoline.

UNIT II

IV. Carbohydrates: Classification and nomenclature, configuration and conformation of monosaccharides, Erythro and threo diastereomers, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Formation of glycoside, ethers and esters. Determination of ring size of monosaccharides. Cyclic structure of D(+) glucose. Mechanism of mutarotation, structure of ribose and deoxyribose. An introduction to disaccharides (maltose, sucrose, lactose) and polysaccharide/starch and cellulose) without involving structure determination.

UNIT III

V. Amino Acids, peptides, proteins and Nucleic Acids: Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis, Preparation and reaction of a amino acids, structure and nomenclature of peptides and proteins. Classification of proteins, peptides structure determination, and group analysis. Selective hydrolysis of peptides. Classical peptide synthesis, solid phase peptide synthesis. Structure of peptides and proteins level of protein structures. Protein denaturation/renaturation.

Nucleic Acids: Introduction - Classification of nucleic acids Ribonueleosides and Ribonucleotides. The double helical structure of DNA.

VI. Fats, Oils and Detergents: Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of

Organic Chemistry

Semester V **Paper 7** **Max Marks: 100 (80 + 20)**

unsaturated oils, saponification value, iodine value, acid value, soaps, synthetic detergents alkyl and aryl sulphonates.

UNIT IV

VII. Synthetic Polymers: Addition or chain-growth polymerization, Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resin, epoxy resins and poly urithanes. Natural and synthetic rubbers.

VIII. Synthetic Dyes: Colour and constitution / electronic concept classification of dyes. Chemistry and synthesis of Methyl orange, conge red, Malachite green, crystal violet, phenophthalein, Fluorescin, Alizarin and Indigo.

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Physical Chemistry

Semester V **Paper 8** **Max Marks: 100 (80 + 20)**

UNIT I

I. Introductory Quantum Mechanics, Physical properties and Molecular Structure: Introductory Quantum Mechanics: Black-body radiation, Plank's radiation law, photoelectric effect, Compton effect.

II. Physical Properties and Molecular Structure: Optical activity, polarization (clausius-Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment, temperature method and refractivity method, dipole moment and structures of molecules, magnetic properties ï paramagnetism, diamagnetism and ferromagnetism.

UNIT II

III. Photochemistry

a. Interaction of radiation with matter, difference between thermal and photochemical processes.

b. Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).

UNIT III

IV. Solutions, Dilute Solutions and Colligative Properties : Ideal and non-ideal solutions, methods of expressing concentration of solutions, activity and activity coefficient, Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, theory of osmotic pressure and its measurement, 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. Experimental methods of determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

UNIT IV

V. Third law of thermodynamics, Nernst heat theorem, statement and concept of residual entropy. Thermodynamic derivation of Nernst distribution law and its application. Phase rule and its derivation. Application of Gibbs phase rule for one component system- water and sulphur system, two component system- Bi-Cd, Pb-Ag, desilverization of lead.

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Physical Chemistry

Semester V **Paper 8** **Max Marks: 100 (80 + 20)**

Books suggested (Theory Courses)

a. Physical Chemistry, G.M. Barrow, International Student Edition, McGraw Hill.
b. Physical Chemistry, R.A. Alberty, Wiley Eastern Ltd.
c. The Elements of Physical Chemistry, P.W. Atkins, Oxford.
d. Physical Chemistry through Problems, S.K. Dogra and S. Dogra Wiley Eastern Ltd.

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Chemistry

Semester V **Practical** **Max Marks: 100**

A: Inorganic Chemistry

I. Synthesis and Analysis

a. Preparation of potassium trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$ and determination of itscomposition by permagnometry.
b. Preparation of Ni-DMG complex, $[Ni(DMG)_2]$
c. Preparation of copper tetraammine complex, $[Cu(NH_3)_4]SO_4$
d. Preparation of cis-and trans-bisoxalatodiaqua chromate (III) ion.

II. Colorimetry

a. To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution.
b. Determination of Fe^{3+} content by thiocyanate method.

III. Solvent Extraction

a. Separation and estimation of Mg(II) and Fe(II) Ion Exchange Method
b. Separation and estimation of Mg(II) and Zn(II).

IV. Chromatography

a. Chromatographic separation of metal ions.

B: Organic Chemistry

I. Mixture Analysis

a. Organic mixture separation and identification (two components)

II. Preparation

b. One step preparation.

C: Physical Chemistry

I. Electrochemistry

a. To determine the strength of the given acid conductometrically using standard alkali solution.
b. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
c. To determine the ionisation constant of a weak acid conductometrically.

II. Refractometry and Polarimetry

a. To verify law of refraction of mixtures (e.g. of glycerol and water) using Abbe's refractometer.
b. To determine the specific rotation of cane sugar solution by polarimeter.

III. Molecular Weight Determination

a. Determination of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
b. Determination of the apparent molecular weight of non volatile solute at different concentration and determine Van't Hoff factor by ebullioscopy.

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Chemistry

Semester V **Practical** **Max Marks: 100**

IV. Colorimetry

a. To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution of the substance.

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Inorganic Chemistry

Semester VI **Paper 9** **Max Marks: 100 (80 + 20)**

Unit - I

I. Metal-ligand bonding in Transition Metal Complexes: Limitation of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors effecting the crystal field parameters. Effect of CFSE on lattice energy, Ionic radii.

Unit - II

II. Magnetic Properties of Transition Metal Complexes: Types of magnetic behaviour, methods of determining magnetic susceptibility, spin only formula, L-S coupling, Spectroscopic ground state, Correlation of ε_S and ε_{eff} values. Orbital contribution to magnetic moments. Application of magnetic moment data for 3d metal complexes.

Unit - III

III. Silicones and phosphazenes as examples of inorganic polymers. Nature of bonding in triphosphazenes. Pseudohalogens and pseudohalides: Preparation, properties and reactions. Structure and bonding of NO, ligand behaviour of NO. Preparation of nitrosyl complexes, effective atomic number (EAN) as applied to nitrosyls.

Unit - IV

IV. Hard and Soft Acids and bases (HSAB) : Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness. Applications of HSAB principle, limitations of HSAB principle.

Text Books (Theory Courses):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
e. Inorganic Chemistry, WW. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.

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Inorganic Chemistry

Semester VI **Paper 10** **Max Marks: 100 (80 + 20)**

Unit – I

I. Thermodynamic and Kinetic Aspects of Metal Complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability. Substitution reaction of square planar complexes. Trans effect.

Unit - II

II. Electronic 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 and d^9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

Unit - III

III. Organometallic Chemistry: Definition, types of organometallic compound and their general methods of preparation of alkyls and aryls of Li, Hg and Sn. Applications of organometallic compounds. Metal carbonyls. 18 electron rule, preparation, structure and nature of bonding in carbonyls.

Unit - IV

IV. Bioinorganic Chemistry: Introduction, metalloenzyme/carboxypeptidase, carboxy-anhydrase. Metalloporphyrens with special reference to haemoglobin and myoglobin (structure, cooperative effect, Bohr's effect). Inorganic complexes in cancer treatment, anti-arthritis drugs, chelation therapy, imaging agents.

Text Books (Theory Courses):

a. Concise Inorganic Chemistry, J.D. Lee, Blackwell Science Ltd.
b. Inorganic Chemistry, Puri, Sharma, Kalia and Kaushal.
c. Pradeep's Inorganic Chemistry, K.K. Bhasin, Pradeep Publication.
d. Chemistry for degree students, R. L. Madan

Reference Books:

a. Inorganic Chemistry, J.E.Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
b. Inorganic Chemistry, D.E.Shriver, P W. Atkins and C.H.L. Langford, Oxford.
c. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson and P.L. Gaus, Wiley.
d. Concepts of Models of Inorganic Chemistry, B.Douglas, D.McDaniel and J Alexander, John Wiley.
e. Inorganic Chemistry, W.W. Porterfield, Addison - Wesley.
f. Inorganic Chemistry, A.G. Sharpe, ELBS
g. Inorganic Chemistry, G.L. Meissler and D.A. Tarr, Prentice-Hall.
h. Bioinorganic Chemistry, K.H. Reddy, New Age

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Organic & Physical Chemistry

Semester VI **Paper 11** **Max Marks: 100 (80 + 20)**

UNIT I

I. Spectroscopy:

a. Rotational Spectroscopy of Diatomic Molecules: Energy level of a rigid rotor (semi classical principles) selection rules, spectral intensity, distribution using population distribution (Maxwell ï Boltzman distribution) determination of bond length, isotope effect.

b. Vibrational Spectrum-Infrared Spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of an harmonic motion and isotope on the spectrum.

c. Raman Spectrum: Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

UNIT II

II. Elementary Quantum Mechanics: de Broglie's hypothesis, the Heisenberg's uncertainty principle, Hamiltonian operator. Statement of Born-oppenheimer approximation. Schrodinger wave equation and its importance. Physical interpretation of wave function, postulates of quantum mechanics, particle in one dimensional box. Schrodinger wave equation for H ï atom and its separations into three equations (without derivation), quantum numbers, wave function, angular wave functions.

III. Basic idea of molecular orbital theory, criteria for forming M.Oûs from A.Oûs, construction of M.O's by LCAO-H^{2+} ion, calculation of energy levels from wave functions, physical picture of bonding and antiboding wave functions, Hybrid Orbitals-sp, sp^2, sp^3, calculation of coefficients of A.O's used in sp and sp^2 hybrid orbital only. Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

UNIT III

I. Electromagnetic Spectrum Absorption Spectra:

a. Ultraviolet (UV) absorption spectroscopy -absorption laws (Beer-Lambert law); molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and Auxochrome, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. U.V.spectra of conjugated enes and enones, woodward fieser rule

b. Infrared (I.R.) absorption spectroscopy- Molecular vibrations, Hook's law, Selection rules, intensity and position of I.R. bands, fingerprint region, characteristic absorptions of various functional groups and interpretation of I.R. spectra of simple organic

Organic & Physical Chemistry

Semester VI **Paper 11** **Max Marks: 100 (80 + 20)**

compounds-hydrocarbons, aldehydes & ketones in IR spectrum (positions only)

UNIT IV

II. Spectroscopy: Nuclear magnetic resonance (NMR): Spectroscopy, proton magnetic resonance (1H NMR) spectroscopy, nuclear shielding and deshielding. Chemical shifts and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of 'H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1, 1, 2 tribromoethane, ethyl acetate, toluene and acetophenones. Problems pertaining to the structure elucidation of simple organic compounds using 1H NMR spectroscopy techniques.

Book Suggested

a. Physical Chemistry G.M. Barrow. International Student Edition IMC Graw Hill.
b. Principles of Physical Chemistry Volume III, B.R.Puri,L.P.Sharma,and M.S.Pathania,Vishal Publication ,Jallandhar
c. Graduate Physical Chemistry,Volume III, L.R.Sharma and M.S .Pathania,2017
d. Fundamentals of Molecular spestroscopy,C.N .Banwell IV edition ,Mc Graw hill education
e. Quantum Chemistry by R.K.Prasad
f. Fundamental Principles of Spectroscopy, B.K.Sharma,Krishna Publication.