

Jananayak Chandrashekhar University
Ballia, UP-277001

M. Sc. (CHEMISTRY) SYLLABUS
(To be effective from session 2018-19)

Semester wise distribution of Courses and marks

Semester-I

Course /paper code	Papers No.	Course title	Marks
	I	Inorganic Chemistry-I	75
	II	Organic Chemistry-I	75
	III	Physical Chemistry-I	75
	IV	Sec-A: Computers for Chemists(Compulsory for all students)	45
		Sec-B: Mathematics For Chemists (For students without Mathematics in B.Sc.)	30
		OR Sec-C: Biology for Chemists (For students without Biology in B.Sc.)	
	Practical	Inorganic, Organic, Physical, Viva voce and Records	100
		Total	400

Semester-II

Course /paper code	Papers No.	Course title	Marks
	I	Inorganic Chemistry-II	75
	II	Organic Chemistry-II	75
	III	Physical Chemistry-II	75
	IV	Spectroscopy and Diffraction methods	75
	Practical	Inorganic, Organic, Physical, Viva voce and Records	100
		Total	400

Semester-III

Course /paper code	Papers No.	Course title	Marks
	I	Application of Spectroscopy	75
	II	Bioinorganic and Bioorganic Chemistry	75
	III	Environmental Chemistry	45
		Photochemistry	30
	IV	Biophysical chemistry and Solid state chemistry	75
	Practical	Inorganic, Organic, Physical, Viva voce and Records	75
		Total	400

Semester-IV

Course /paper code	Papers No.	Course title	Marks
	I	Analytical Chemistry	75
	II	Inorganic Polymers	75
	III	Organic Synthesis-I	75
	IV	Medicinal Chemistry	75
	Practical	Inorganic, Organic, Physical, Viva voce and Records	100
		Total	400

Semester-1

Paper-I

Inorganic Chemistry –I

UNIT-I: Symmetry and Group Theory

- (a) Symmetry elements and symmetry operations with reference to water, ammonia, ethane, benzene, etc.
- (b) Classifications of molecules/ions based on their symmetry properties.
- (c) Derivation of matrices for rotation, reflection, and inversion operations
- (d) Symmetry point groups applied to all types of molecules C_{nh} , D_{nh} , C_{nv} , I_d , O_h .
- (e) Group multiplication basis, matrix representation, character of a representation, character table, reducible and irreducible representation, group, groups and subclasses.

UNIT-II: Stereochemistry and Bonding in Main Group Compounds

VSEPR. Walsh diagrams (tri and penta-atomic Molecules), d^7r-p^7r bonds, bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

UNIT-III: Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH metry and spectrophotometry.

UNIT — IV: Metal-Ligand Bonding

Limitation of crystal field theory, molecular orbital theory. Octahedral, tetrahedral and square planar complexes, π -bonding and molecular orbital theory.

Books Recommended.

1. F.A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, 6th Edn.(1999), John Wiley & Sons, New York.
2. James E. Huheey, Inorganic Chemistry, 4th Edn. (1993), Addison-Wesley Pub. Co., New York.
3. Chemistry of the elements, N. N. Greenwood and A. Earnshaw, Pergamon.
4. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier.
5. Comprehensive Coordination Chemistry eds., G Wilkinson, R. D. Gillars and J. A. Mc Cleverty. Pergamon.
6. Magneto Chemistry, R. L. Carlin, Springer Verlag.

Semester-I
Paper II – Organic Chemistry-I

UNIT-I:

Nature of bonding in Organic Molecules

Delocalized chemical bonding-conjugation, cross conjugation, resonance, Hyperconjugation, bonding in fullerenes. Aromaticity in benzenoid and non-benzenoid Compounds, Huckel's rule, energy level of pi-molecular orbitals, annulenes, antiaromaticity.

UNIT-II

A- Stereochemistry Conformational analysis of cycloalkanes, decalines, effect of conformation of reactivity Elements of symmetry, chirality, molecule with more than one chiral center, threo and erythro isomers, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon biphenyl's, alleries.and spiranes B- Reaction mechanism, Structure and reactivity Methods of determining mechanism, isotope effect. Generation structure, stability and reactivity of benzyne, carbenes and nitrenes. Effect of structure on reactivity resonance and field effect, steric effect, quantitative treatment.

UNIT-III

Aliphatic nucleophilic substitution

The SN₂, SN₁, mixed S_N1 and SN₂, the neighboring group mechanism, neighboring group participation by Pi and Sigma bonds, anchimeric assistance Classical and non classical carbocations. The SN; mechanism nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile. leaving group and reaction medium, ambident nucleophile, regioselectivity.

UNIT-IV:

A- Aromatic electrophilic substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The Ortho/Para ratio, ipso attack, orientation in other ring systems. Vilsmeier reaction, Gattermann-Koch reaction.

B- Aromatic nucleophilic substitution •

The S_NAr. SN₁, benzyne and S_{RN}1 mechanism. Reactivity effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet Hauser, and Smiles rearrangements.

BOOKS SUGGESTED

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R3. Sundberg. Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd. Prentice Hall.
6. Modern Organic Reactions H.O. House, Benjamin
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic and professional.
8. Pericyclic Reactions. S.M. Mukherji, Macmillan India.
9. Reaction Mechanism in Organic Chemistry : S.M. Mukherji and S.P. Singh, Macmillan.
10. Stereochemistry of Organic Compounds D. Nasipuri, New Age International.
11. Stereochemistry of Organic Compounds, P.S Kalsi, New:Age, International.

Semester-I

Paper III: Physical Chemistry-I

UNIT-I: Vibrational Spectroscopy

A. Infrared Spectroscopy

Review of linear harmonic oscillator. vibrational energies of diatomic molecules, zero point energy, force constant and bond strength: anharmonicity, P.Q.R. branches, vibrations of polyatomic molecules, Selection rules, normal modes of vibration. Factors affecting the band positions and intensities.

B. Raman Spectroscopy Classical and quantum theories of Raman effect Pure rotational, vibrational and vibrational-rotational Raman spectra. selection rules. mutual exclusion principle. Applications of Raman spectroscopy.

UNIT- II :Quantum Chemistry

A. Fundamental Background Operators,

Postulates of Quantum Mechanics, Hamiltonian for different systems, Angular momentum. •

B. Introduction to Exact quantum Mechanical Results:

The Schrodinger equation. discussion of solutions of the Schrodinger equation to some model system viz. particle in a box .the harmonic oscillator, the rigid rotator, the hydrogen atom.

UNIT- III : Quantum Chemistry.

A .Approximate Methods:

The Variation theorem, linear variation principle. Perturbation theory (First order and nondegenerate)\ Application of variation method and perturbation theory to the H₂ molecule and H₂⁺ ion.

B. Electronic structures of Atoms:

Russel-Saunders terms and coupling schemes, term symbols for the pⁿ and dⁿ configurations Spin orbit coupling and Zeeman splitting, introduction to the methods of self-consistent field, Slater's type orbitals.

UNIT- IV: Chemical Dynamics

Methods of determining rate law, collision theory of reaction rates steric factors Activated complex theory, Arrhenius equation and the activated complex theory. Ionic reactions kinetic salt effect, steady state kinetics. Dynamic chain(hydrogen-bromine reaction ,pyrolysis of acetaldehyde) photochemical (hydrogen-bromine reaction hydrogen-chloride reactions) and oscillatory reactions (Belousov Zhabotinsky reaction) homogeneous catalysis, kinetics of enzyme reaction General features of fast reaction study of fast reaction by relaxation method flash photolysis and the nuclear magnetic resonance method. Dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice -Rampersperger-kassel -marcus (RRKM) theories of unimolecular reactions)

BOOKS SUGGESTED

1. Modern Spectroscopy. J.M. Hollas, John Wiley.
2. Physical methods in chemistry R.S. Drago, Saunders College.
3. Introduction to Molecular Spectroscopy G.M. Barrow, McGraw Hill.
4. Physical Chemistry P.W Atkins PLBS.
5. Introduction to Quantum Chemistry, A.K. Chandi., Tata McGraw Hill .
6. Quantum Chemistry. Ira N. Levine. Prentice Hall.
7. Coulson's Valency. R. McWeeny, ELBS.
8. Chemical Kinetics. K.J. Laidler. McGraw-Hill.

Kinetics and Mechanism of Chemical Transformations J. Rajaraman and J. Kuriacose McGraw Hill.

Semester-I Paper IV

Sec-A: Computers for Chemists (Compulsory for all students)

This is a theory-cum-laboratory course with more emphasis on laboratory work.

UNIT- I: Introduction to Computer and Computing:

Basic structure and functioning of computers with a PC as an illustrative example Memory, I/O devices, Secondary storage. Computer languages. Operating systems with DOS as an example. Introduction to UNIX and WINDOWS Data Processing principles of programming. algorithms and flowcharts.

UNIT- II: Computer Programming in FORTRAN/C/BASIC:

The language features are listed here with reference to FORTRAN. The instructor may choose another language such as BASIC or C and the features may be replaced appropriately. Elements of the computer language. Constants and variables. operations and symbols, expressions. Arithmetic assignment statement. Input and Output. Format statement. Termination statements. Branching statements such as IF or GO TO statement. LOGICAL variables. Double precision variables. Subscripted variables and DIMENSION. DO statement FUNCTION and SUBROUTINE. COMMON and DATA statements. (Students learn the programming logic and these language features by hands on experience on a personal computer from the very beginning of this topic)

UNIT- III : Programming in Chemistry:

Development of small computer codes involving simple formulae in chemistry such as van der Waals equation, pH titration. kinetics. radioactive decay. Evaluation of lattice energy and ionic radii from experimental data. Linear simultaneous equations to solve secular equations within the Huckel theory. Elementary structural features such as bond lengths. bond angles, dihedral angles etc. of molecules extracted from a database such as Cambridge data base.

UNIT- IV : Use of Computer Programmes The students will learn how to operate a PC and how to run standard programmes and packages. Execution of linear regression. X-Y plot. numerical integration and differentiation as well as differential equation solution programmes. Monte Carlo and Molecular dynamics. Programmes with data preferably from physical chemistry laboratory Further, the students will operate one or two of the packages such as MATLAB EASYPLOT LOTUS FOXPRO and Word processing software such as WORDSTAR/MS WORD.

Books Suggested

1. Computers and common Sense, R. Hunt and I. Shelley. Prentice Hall.
2. Computational Chemistry, A.C. Norris.
3. Microcomputer Quantum mechanics, J.P. Killngbeck. Aoam Eiger.
4. Computer Programming in FORTRAN IV, V. Rajaraman, Prentice Hall.
5. An Introduction to Digital Computer Design. V. Rajaraman and T. Radhakrishana Prentice Hall.

Semester-I

Paper IV

Sec-B: Mathematics For Chemists

(For students without Mathematics in B.Sc.)

UNIT- I: Vectors and matrix Algebra

A- Vectors

Vectors, dot, Cross and triple products etc. The gradient, divergence and curl.

B- Matrix Algebra

Addition and multiplication: inverse, adjoint and transpose of matrices, special matrices (Symmetric, skew-symmetric Hermitian, skew-Hermitian, unit, diagonal, unitary etc) and their properties Matrix equations: homogeneous, non-homogeneous linear equations and conditions for the solution, matrix eigenvalues diagonalisation determinants (examples from Huckel theory)

UNIT- II: Calculus

A- Differential Calculus

Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels. Bohr's radius and most probable velocity from Maxwell's distribution etc) exact and inexact differentials with their applications to thermodynamic properties.

B- Integral calculus.

Basic rules for integration, integration by parts. partial fraction and substitution. Reduction formulae applications of integral calculus. Functions of several variables. partial differentiation. co-ordinate transformations (e.g. cartesian to spherical polar).

UNIT- III: Elementary Differential Equations

Variables-separable and exact first-order differential equations. homogeneous. exact and linear equations. Applications to chemical kinetics. secular equilibria, quantum chemistry etc . Solutions of differential equations by the power series method, Fourier series, solutions of harmonic oscillator and Legendre equation etc., spherical harmonics second order differential equations and their solutions.

UNIT- IV: Permutation and Probability

Permutations and combinations, probability and probability theorems, probability curves, average, root mean square and most probable errors, examples from the Kinetic theory of gases etc.

Books Suggested

1. The chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sucliffe. Longman.
3. Mathematical preparation for Physical Chemistry. F. Daniels Mc Graw Hill.
4. Chemical Mathematics, D.M. Hurst, Longman.
5. Applied Mathematics for Physical Chemistry. J.R. Barrante. Prentice Hall.
6. Basic Mathematics for Chemists, Tebbutt. Wiley.

Semester-I

Paper IV Section - 'C'

Biology for Chemists

(For students without Biology in B.Sc.)

UNIT- I: A- Cell Structure and Functions

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview biological energy currency. Introduction to biomolecules. building blocks of biomacromolecules.

B-Carbohydrates

Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars. N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides-cellulose and chitin. Structure and biological functions of glucosaminoglycans or mucopolysaccharides. Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Carbohydrate metabolism, Kerb's cycle, glycolysis, glycogenesis, gluconeogenesis pentose-phosphate pathway.

UNIT- II: Lipids.

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. properties of lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure Lipid metabolism β oxidation of fatty acids.

UNIT- III : Amino-acids, Peptides and proteins

Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structure α -helix, β sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein folding and domain structure. Quaternary structure. Amino acid metabolism-degradation and biosynthesis of amino acids. sequence determination chemical/enzymatic/mass spectral. racemization/detection. Chemistry of oxytocin and tryptophan releasing hormone (TRH).

UNIT- IV : Nucleic Acids

Purine and pyrimidine bases of nucleic., acids, base pairing via H-bonding structure of ribonucleic acid (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity and overview of replication of DNA, transcription, translation and genetic code. Chemical synthesis of mono and trinucleoside.

Books Suggested

1. Principles of Biochemistry, A.L Lehniger Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J,David Rawn, Nell Patterson.
4. Biochemistry Voet and Voet, John Wiley.

5. Outlines of Biochemistry, E.E.Conn and P.K. Stumpt, John Wiley.

Semester-I
Practicals

Marks 100: Time 12 hOurs in two days

Note:-

- i) A complete records of practical exercises; in Inorganic, Organic and Physical Chemistry done during the session must be produced by the candidates in three separate Record Books at the time of practical examination.

Inorganic Chemistry

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| 1. Qualitative analysis of mixtures | 20 |
| Qualitative analysis of mixture containing trace elements Tl, Mo, W, Zr, Ti, Th, V, U (Two metal ions in cationic/anionic forms) and insoluble oxides, sulphates and halides. The mixture should not contain more than five cations and should be analyzed by semi micro technique. | |
| 2. Paper chromatography | 05 |
| Paper chromatography separation of a mixture of the following and measurements of Rf values. a) Pb^{+2} , Ag^+ , Hg^{+2} (b) Co^{+2} , Ni^{+2} , Cu^{+2} (c) Ba^{+2} , Ca^{+2} , Sr^{+2} | |

Organic Chemistry

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|--|----|
| 1. Qualitative Analysis | 15 |
| Separation, purification, and identification of binary mixture. Preparation of derivatives if possible | |
| 2. Organic Synthesis | 10 |
| i. Adipic acid by chromic acid oxidation of cyclohexanol. | |
| ii. Triphenyl methanol from Benzoic acid. | |
| iii. Dibenzal acetone from Benzaldehyde. | |
| iv. p-chlorotoluene from p-toluidine | |
| v. Synthesis of p-nitroaniline and p-bromoaniline. | |

Physical Chemistry (Any one)	25
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1. Study the adsorption of acetic acid on charcoal and draw the Freundlich isotherm.
2. Show that the order of reaction between acetone and Iodine is zero with respect to Iodine
3. Determination of congruent composition and temperature of a binary mixture e.g. diphenylamine-benzophenone system.
4. Determination of glass transition temperature of a given salt (e.g., $CaCl_2$) conductometrically.
5. Determination of the velocity constant of hydrolysis of an ester / ionic reaction in micellar media.
6. Determination of the velocity Constant of decomposition of Benzene diazonium chloride.
- 7.

Viva	15
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Records	10
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Semester-II

Inorganic-II (Paper I)

UNIT- I: Reaction mechanism of Transition Metal Complexes

Energy profile of a reaction, reaction reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reaction, reaction without metal ligands bond cleavage. Substitution reaction in square planar complexes. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross-reactions and Marcus-Hush theory, inner sphere type reactions.

UNIT- II : Electronic spectra and Magnetic , Properties of Transition Metal Complexes: Spectroscopic ground states; Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes (d^1 - d^9 states); Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation of ligand-field parameters.

UNIT- III : Metal π -Complexes

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

UNIT- IV: A- Metal Clusters

Higher boranes, carboranes, metallocarboranes

B- Isopoly and heteropoly acids and salts

Books Recommended

1. F.A. Cotton and G. Wilkinson *Advanced Inorganic Chemistry*, 6th Edn. (1999), John Wiley & Sons, New York.
2. James E. Huheey, *Inorganic Chemistry*, 4th Edn. (1993), Addison-Wesley Pub. Co., New York.
3. Chemistry of the elements, N. N. Greenwood and A. Earnshaw, Pergammon.
4. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier.
5. Comprehensive Coordination Chemistry eds., G Wilkinson, R. D. Gillars and J. A. Mc Cleverty. Pergammon.

Semester-II
Organic-II (Paper II)

UNIT- I : Free radical reactions:

Free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. The effect of solvent on reactivity. Arylation of aromatic compounds by diazonium salt. Hunsdiecker reaction.

UNIT- II : A- Addition to carbon-carbon multiple bond:

Mechanistic and stereochemical aspects of addition reactions involving electrophile, nucleophile and free radicals, regio and chemo selectivity, orientation and reactivity. Hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

B-Addition to carbon heteroatom multiple bonds:

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles, Wittig reaction mechanism of condensation reactions involving enolate, Knoevenagel, Mannich, Stobbe reactions.

Hydrolysis of esters and amides, ammonolysis of esters. **UNIT- III : Elimination reactions:**

The E2, E1 and E1cB mechanism. Orientation of double bond. Reactivity effect of substrate structures. Attacking base, the 'leaving group' and the medium. Mechanism and orientation on Pyrolytic elimination.

UNIT- IV: Pericyclic reactions :

Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and disrotatory motions, $4n$, $4n+2$ and allyl systems. Cycloadditions-antarafacial and Suprafacial 'additions, $4n$ and $4n+2$ system, Sigmatropic rearrangements-superfacial and antarafacial shift of H, sigmatropic shifts involving carbon moieties, 3,3 and 5,5 sigmatropic rearrangements. Claisen- Cope and Azape rearrangement. Fluxional tautomerism. Ene reaction.

BOOKS SUGGESTED

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg. Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd. Prentice Hall.
6. Modern Organic Chemistry H.O. House, Benjamin .
7. Principles of Organic Synthesis, R.C. Norman and J.M. Coxon, Blackie Academic and professional.
8. Pericyclic Reactions. S.M. Mukherji, Macmillan India.
9. Reaction Mechanism in Organic Chemistry S.M. Mukherji and S.P. Singh, Macmillan.
10. Stereochemistry of Organic Compounds D. Nasipuri, New Age International.

Semester-II
Physical -II (Paper III)

UNIT- I: Thermodynamics

A-Classical Thermodynamics: Brief resume of concepts of laws of thermodynamics, free energy and chemical potential. Partial, molar properties partial molar free energy, partial molar volume and its determination, Gibbs—Duhem equation, concept of fugacity (by graphical method), Activity and Activity coefficient.

B-Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution. Canonical, grand canonical and microcanonical ensembles, The Boltzmann distribution law. Partition Functions—translational, rotational, vibrational and electronic partition function. Calculation of thermodynamic properties and equilibrium constant in terms of partition function. Fermi-Dirac and Bose-Einstein statistics.

C-Non-Equilibrium Thermodynamics: Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, Entropy balance equation for different irreversible processes (e.g. heat flow, chemical reaction etc.). Transformation of the generalized fluxes and forces non-equilibrium stationary, phenomenological equations, Onsager's reciprocity relation, electrokinetic phenomena.

UNIT- II: Surface chemistry:

A-Adsorption: Gibbs adsorption isotherm estimation of surface area (BET equation), surface films on liquids (electrokinetic phenomenon), catalytic activity at surfaces.

B-Micelles: Surface active agents, classification of surface active agents, micellization hydrophobic interactions, Critical micellar concentration (CMC) Factors affecting CMC of surfactants counter ion binding to micelles, solubilization microemulsion reverse micelles.

UNIT- III: Macromolecules:

Polymer—definition, types of polymer, electrically conducting fibre resistant, liquid crystal polymer, Kinetics of polymerization, Molecular mass, number and mass average molecular mass, molecular mass determination (Osmometry, Viscometry, diffusion and light scattering method) sedimentation chain configuration of macromolecules, Calculation of average dimension of various chain structures.

UNIT- IV: Electrochemistry:

Debye-Huckel theory of activity coefficient of electrolytic solutions, applicability and limitations of Debye-Huckel limiting law, ionic strength, structure of electrified interfaces, Helmholtz-Perrin, Guoy-Chapman and Stern models. Over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plot. Electrocatalysis, Influence of various parameters, Hydrogen electrode. Polarography theory, interpretation of a polarographic curve, instrumentation, limiting current, residual and charging current, diffusion current. Supporting electrolytes, Lkovic equation, half wave potential and its significance. Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and prevention methods.

BOOKS SUGGESTED

1. Kinetics and Mechanism of Chemical Transformations J. Rajaraman and J. Kuriacose Me Millan.
2. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
3. Modern Electrochemistry Vol. I and Vol. II J.O.M. Bockris and A.K.N. Reddy, Plenum.
4. Introduction to Polymer Science V.R. Gowarikar, N.V. Vishwanathan and J.Sridhar, Wiley Eastern.
5. Physical Chemistry P.W. Atkins, ELBS.

Semester-II
Spectroscopy and Diffraction method (Paper IV)

' UNIT- I: Electronic Spectroscopy

A- Atomic Spectroscopy

Energies of atomic orbitals, spectra of hydrogen atom and alkali metal atoms.

B- Molecular Spectroscopy

Franck-Condon principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

C- Photoelectron Spectroscopy

Basic principles; photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA. Auger electron spectra of simple molecules.

UNIT- II : Nuclear Magnetic Resonance Spectroscopy

A- magnetic Resonance Spectroscopy

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shift deshielding, spin-spin interactions, factors influencing coupling constant 'J' Effect of chemical exchange, spin decoupling, basic ideas about instrument, NMR studies of nuclei other than proton-¹³C, ¹⁹F and ³¹P. FT NMR, advantages of FT NMR use of NMR in medical diagnostics.

B-Nuclear Quadrupole Resonance Spectroscopy

quadrupole nuclei quadrupole moments, electric field gradient, coupling constant, splittings, Applications.

UNIT- III :

A- Electron Spin Resonance-Spectroscopy

Basic principles, Zero field splitting and Kramer's degeneracy. Factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants _measurement techniques and applications.

B-Photoacoustic Spectroscopy

Basic principles of photoacoustic spectroscopy (PAS), PAS- gases and condensed systems, chemical and surface applications.

UNIT- IV

A-X-ray Diffraction

Bragg method of X-ray structural analysis of crystals, index reflections. Structure of simple lattices and X-ray intensities.

B-Electron Diffraction

Scattering intensity vs. scattering angle. **Books suggested:** measurement technique, elucidation of structure of simple gases, liquids, and solids.

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy for Chemical Analysis ed. H. Windawi and F.L. Ho. Wiley interscience.
3. NMR, NQR, EPR and mossbauer Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Harwood.
4. Introduction to Molecular Spectroscopy G.M. Barrow, Mc Graw Hill.
5. Basic principles of Spectroscopy. R. Chang. Mc Graw Hill.

Practicals Semester-II

Marks 100: Time 12 hours in two days

Note:-

A complete record of practical exercise: in Inorganic, Organic and Physical Chemistry done during the session must be produced by the candidates in three separate Record Books at the time of practical examination.

Inorganic Chemistry

- I. Either both gravimetric and volumetric estimation of two metal ion from following mixtures: 20
(a) Cu^{+2} and Ni^{+2} (b) Cu^{+2} and Zn^{+2} (c) Ni^{+2} and Zn^{+2} (d) Ba^{+2} and Ag^{+2}
- II. Preparation of selective inorganic compounds (any one) 05
(a) $\text{VO}(\text{acac})_2$
(b) $\text{Na}[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$
(c) $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$
(d) Prussian Blue
(e) $[\text{Co}(\text{Py})_2\text{Cl}_2]$
(f) $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$

Organic Chemistry

25

Quantitative Synthesis (Any Two)

- I. Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.
- II. Estimation of amine phenols using bromate bromide solution or acetylation method.
- III. Determination of iodine and saponification values of an oil sample.
- IV. Determination of DO, COD and BOD of water sample.

Physical Chemistry (Any one)

25

- I. Determination of molecular weight of nonvolatile and nonelectrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte.
- II. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.
- III. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
- IV. Determination of solubility and solubility product of sparingly soluble salts (e.g PbSO_4 , BaSO_4) conductometrically.
- V. Determination of the strength of strong and weak acids in a given mixture conductometrically

VI. Viva

15

VII. Records

10

Semester-III

Paper-I

(Applications of Spectroscopy)

UNIT- I: Applications of Spectroscopy in Inorganic Chemistry

A- Vibrational Spectroscopy

Symmetry and shapes of AB₂, AB₃ and AB₄, mode of bonding of ambidentate ligands such as thiocyanate, nitrate, sulphate and urea, application of Raman spectroscopy particularly for the study of ionic equilibrium in solution.

B- Electron Spin Resonance Spectroscopy

Hyperline coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling-Ad significance of g-tensors, application to transition metal complexes having one unpaired electron and inorganic free radicals such as PH₄, F₂ and BH₃.

C- Mossbauer Spectroscopy

Basic principles, spectral parameters and spectrum display. Application of the techniques to the studies of (1) bonding and structures of Fe²⁺ and Fe³⁺ compounds including those of intermediate spin and (2) Sn²⁺ and Sn⁴⁺ compounds nature of M-L bond, coordination Number, structure.

UNIT- II: Applications of Spectroscopy-I in organic Chemistry

A- Ultraviolet and Visible Spectroscopy

Various electronic transitions (185-800 nm). Beer Lambert law. Effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, ultraviolet spectra of aromatic and heterocyclic compounds.

B- Infrared Spectroscopy

Characteristic vibrational frequencies of aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides and acids), effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonances.

UNIT- III: Applications of Spectroscopy-II in organic Chemistry

A- Nuclear Magnetic Resonance Spectroscopy

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols and carboxylic acids) chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (first order spectra).

B- Carbon-13 NMR Spectroscopy

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants.

UNIT- IV: Applications of Spectroscopy-III in organic Chemistry

Mass Spectrometry

Introduction, ion production-. EI, CI, FD and FAB, factors affecting the fragmentation, ion analysis, ion abundance, mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, Nitrogen rule.

Books suggested

1. Physical Methods for Chemistry, R.S.Dargo, Saunders Company
2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, Rankin and Cradock- ELBS.
3. Infrared and Raman Spectra Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
4. Progress in Inorganic Chemistry, 8 edition, F. A. Cotton
5. Transition Metal Chemistry, ed..L.Carlin, vol. 3, Dekker.
6. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
8. Practical NMR Spectroscopy, M. L.Martin, J. J. Delpuech and G. J. Martin, Heyden.
9. Spectrometric Identification of Organic Compounds, R.M. Silverstein. G.C. Bassler and T.C. Morin John Wiley.
10. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fischer and P. Loftus Wiley.
11. Application of Spectroscopy of Organic Compounds J. R. Dyer, Prentice Hall,
12. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata Mc-Graw Hill.

Paper-II
Section-'A':(Bioinorganic Chemistry)
UNIT- I

Metal Ions in Biological Systems

Essential and trace metals

Na⁺/K⁺ Pump

Role of metal ions in biological processes

UNIT- II

Bioenergetics and ATP cycle

Di\ po ymertniglucose storage, metal complexes in transmission of energy: chlorophylls **B- Transport and Storage of Dioxygen**
Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, haemocyanins and hemerythrin model synthetic complexes in iron, cobalt and copper

UNIT- III

Electron Transfer in Biology

Structure and function of metalloproteins in electron transport processes-cytochromes and iron-sulphur proteins.

UNIT- IV

Nitrogenase

Biological nitrogen fixation, molybdenum nitrogenase

Books suggested

1. Principle of Bioinorganic Chemistry, S. J. Lippard and J.M. Berg, University Science Books
2. Bioinorganic Chemistry, Bertini H.B. Gray, S.J.Lippard and J.S. Valentine, University Science Books
3. Inorganic Biochemistry, vols. I and ed. G.L. Eichhorn, Elsevier.
4. Progress in Inorganic Chemistry, Vols 18 & 38 ed. J.J. Lippard, Wiley.

Section-'B'
Bioorganic Chemistry
UNIT- I

A-Introduction

Basic consideration Proximity effects and molecular adaptation

B-Enzymes

introduction and historical perspective chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

UNIT- II

A-Mechanism of Enzyme Action

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase-A.

B-Kinds of Reactions Catalysed by Enzymes

Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes
Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerization reactions, 1,3-cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

UNIT- III

A- Co-Enzyme Chemistry

Cofactor as derived from vitamins coenzyme S, Prosthetic groups, apoenzymes structure and biological functions of coenzyme A thiamine pyrophosphate, pyridoxal phosphate. NAD, NADP, FMN, FAD, lipoic acid, vitamin B12.

H-Enzyme Models

Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry crown ethers, cryptates Cyclodextrins. cyclodextrin- based enzyme models calixarenes ionophores. micelles. synthetic enzymes or synzymes.

UNIT- IV

Biotechnological Applications of Enzymes

Large-scale production and purification of enzymes techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy.

Books Suggested

1. Bioorganic Chemistry: A chemical Approach to Enzyme Action, Hermann Dugas and C. Penny. Springer Verlag. 2. Understanding Enzymes, Trevor Palmer, Prentice Hall.
3. Enzyme Chemistry: Impact and Applications, Ed. Collin J. Suck Chapman and Hall.
4. Enzyme Mechanisms De. M.I. Page and A. Williams. Royal Society of Chemistry
5. Fundamentals of Enzymology. N.C. Price and L. Stevens. Oxford University Press.
6. Immobilized Enzymes: An introduction and application in Biotechnology- Michael D. Trevan- John Wiley.
7. Enzyme Structure and Mechanism, A Fersht, W.H. Freeman.
8. Biochemistry: The Chemical Reactions of Living Cells. D.E. Metzler. Academic Press.

Semester- III
Paper- III
Section- 'A'
(Environmental Chemistry)
UNIT- I

A-Environment

Introduction, Composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and O. Biodistribution of elements.

B- Hydrosphere

Chemical composition of water bodies-lakes, streams, rivers and wet lands etc. Hydrological cycle. Aquatic Pollution- inorganic, organic, pesticide, agricultural industrial and sewage, detergents, oil spills and oil pollutants, Water quality parameters-dissolved oxygen biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se, etc.), residual chloride and chlorine demand. Purification and treatment of water.

UNIT- II

A- Soils

Composition micro and macro nutrients. Pollution-fertilizers, pesticides plastics and metals. Waste treatment.

B- Atmosphere

Chemical composition of atmosphere-particles, ions and radicals and their formation Chemical and photochemical reactions in atmosphere, smog formation, oxides of N.C.S.O. and their effect, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons Green house effect, acid rain, air pollution controls and their chemistry. Analytical methods for measuring air pollution, Continuous monitoring instruments

UNIT- III

Industrial Pollution

Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy, polymers, drugs etc. Radionuclide analysis. Disposal of wastes and their management.

UNIT- IV

Environmental toxicology

Chemical solutions to environmental problems, biodegrade ability, principles of decomposition better industrial processes. Bhopal gas tragedy, Chernobyl, three *mile* island. Sewoza and Minamata disasters.

Books Suggested

1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
2. Environmental Chemistry, Sharma & Kaur, Krishna Publishers
3. Environmental Chemistry, A.K. De, Wiley Eastern. .
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern
5. Standard method of Chemical Analysis, *Fl. Welcher* Vol: **III** Van Nostrand Reinhold Co
6. Environmental Toxicology. *Ed.L* Rose, Gordon and Breach Science Publication.
7. Elemental Analysis of Airborne Particles. Ed. S.Landsberger and M. Creachman, Gordon and Breach Science Publication.
8. Environmental Chemistry. C. Baird. W.H. Freeman.

Semester- III

Paper- III

Section-`B`

(Photo Chemistry)

UNIT- I: Photochemical Reactions

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy actinometry.

UNIT- II: Determination of Radical Mechanism

Classification rate constants and life times of reactive energy, states-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions.

UNIT- III :

A-Photochemistry of Alkenes: Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclization reactions, rearrangement of 1,4- and 1,5- dienes.

B- Photochemistry of Carbonyl Compounds

Intramolecular reactions of carbonyl compounds- saturated cyclic, acyclic α,β unsaturated and α,γ unsaturated compounds, cyclohexadienones.

Intermolecular cycloaddition reactions-dimerization and oxetane formation.

UNIT- IV Photochemistry of Aromatic Compounds

Isomerizations, additions and substitutions.

Books suggested

13. Fundamentals of Photochemistry, K.K. Rohtagi Mukherji, Wiley Eastern.
14. Essentials of Molecular Photochemistry, A. Gilbert, BaggotBalckwell Scientific Publications.
15. Introductory Photochemistry, A. Cox and T. Camp, McGraw Hill.
16. Photochemistry, R. P. Kundall and A. Gilbert, Thomson Nelson.
17. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.

Semester- III
Paper- IV
(Biophysical chemistry and Solid state chemistry)
UNIT- I:

A- Biological cell and its Constituents

Biological cell, structure and functions of proteins, enzymes. DNA and RNA in living systems. Helix coil transition.

B- Bioenergetics

Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.

UNIT- II

A-Biopolymer Interactions

Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic force, dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves.

B-Thermodynamics of Bionolymer Solutions

Thermodynamics of biopolymer solutions, osmotic pressure membrane equilibrium, muscular contraction and energy generation in mechanochemical system.

UNIT- III

A-Cell membrane and Transport of ions

Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction.

B- Biopolymers and their Molecular Weights

Evaluation of size shape molecular weight and extent of hydration of biopolymers by various experimental techniques. Sedimentation equilibrium, hydrodynamic methods, diffusion, sedimentation velocity viscosity electrophoresis and rotational motions.

UNIT- IV: Solid state chemistry

A- Solid State Reactions

General Principles for reaction between two solids: Reaction conditions, structural considerations, surface area, reactivity, kinetics of solid state reactions.

B- Crystal Defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects- point defects, vacancies- Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, non-stoichiometry and defects.

C- Electronic Properties and Band Theory

Metals, insulators and semiconductors, electronic structure of solids-band theory, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. Optical properties- optical reflectance, photoconduction- photoelectric effects. **Book Suggested**

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J.David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistr, E.E. Conn and f.K. Stumpf, John Wiley.
6. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, H.Dugas and C. Penny, SpringerVerlag.
7. Marcomolecules: Structure and Functions, F. Wold, Prentice Hall.
8. Solid sate Chemistry and its Applications, A.R..West, Plenum.
9. Principles of the Solid State, H. V. Keer, Wiley Eastern.
10. Solid State Chemsitry, N. B. Hannay.
11. Solid State Chemistry, D.K. Chakrabarty, New Age International.

Semester III Practicals

Marks: 100 : Time 12 hours in two days

Inorganic

25

1. Preparation of selected inorganic compounds and structural elucidation on the basis of given spectra (IR, ESR and MS) Selection can be made from the following

- 1- Sodium amide
- 2- Dichlorophenyl borane PhBCl_2
- 3- Sn(IV) Iodide, Tin (IV) chloride and Tin (II) iodide
- 4- Ammonium hexachlorostannate $\text{CNH}_4\text{SnCl}_6$,
- 5- Trichlorodiphenyl antimony (v) hydrate
- 6- Sodium Tetrathionate, $\text{Na}_2\text{S}_4\text{O}_6$
- 7- Metal Complexes of dimethyl Sulfoxide, CuCl_2 , 2DMSO.
- 8- Metal acetylacetonate.
- 9- Ion exchange separation of oxidation state of V.
- 10- Preparation of Fe(II) Chloride.
- 11- Phosphine Ph_3P and its transition metal complexes.
- 12- Ferrocene
- 13- Copper glycine Complex

II Chromatographic Separations:

- a- Thin layer chromatographic separation of Nickel, Manganese Cobalt and Zinc. Determination of R_f values.
- b- Cadmium and Zinc
- c- Zinc and Magnesium

ORGANIC CHEMISTRY

25

I. Qualitative Analysis

Separation and identification of components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid). Suitable derivatives to be prepared where possible. Purity of the separated components should also be checked on TLC plates, Chemical analysis.

II. Isolation of the following

- i) Caffeine from tea leaves.
- ii) Casein from milk
- iii) Lactose from milk
- iv) Nicotine dipicrate from tobacco
- v) Lycopene from tomatoes.

PHYSICAL CHEMISTRY

25

Thermodynamics:

I- Determination of partial molar volume of solute (e.g, KCl) I and solvent in a binary mixture.'

II- Determination of the temperature dependence of the solubility of a compound in two solvents having similar inter molecular interactions (benzoic acid in water and in DMSO water mixture) and to calculate the partial molar heat solution

Spectroscopy

- i Determination of pK_a of an indicator (e.g. methyl red) 10 (a) aqueous and (b) micellar media.
- ii. Determination of stoichiometry and stability constant of inorganic (e.g. ferric-salicylic acid) and organic (e. g. amine iodine) complexes. Characterization of the complexes by electronic and IR spectral data.

Viva voce

15

Records

10

Semester- IV
Elective Paper I
Analytical chemistry
UNIT - I

Introduction

Role of analytical chemistry. Classification of analytical methods-classical and instrumental. Types of instrumental analysis, selecting an analytical method. Neatness and cleanliness, laboratory operations and practices, analytical balance. Techniques of weighing, errors. Volumetric glassware-cleaning and calibration of glassware. Sample preparations, dissolution and decompositions. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

UNIT- II

Errors and evaluation

Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data determinate (systematic), indeterminate (of random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics.

UNIT- III

A- Food analysis

Moisture, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination in foodstuffs. Microscopic examination of food for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC, gas chromatography for organophosphates. Thin layer chromatography for identification of chlorinated pesticides in food products.

B-Analysis of water pollution

Origin of waste types water pollutants and effects. Sources of water pollution domestic, industrial, agricultural, soil and radioactive waste as sources of pollution, objectives of analysis-parameter for analysis-colour turbidity total solid conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Heavy metal pollution, public health significance of Cadmium, Chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Measurement at DO, BOD, COD. Pesticides as water pollutants and analysis. Water pollution law and standards.

UNIT- IV

Analysis of soil, fuel, body fluids and drugs

- (a) Analysis of soil: moisture, pH, total nitrogen, phosphorus, silicon, lime, magnesia, manganese, sulphur and alkali salts.
- (b) Fuel analysis: solid, liquid and gas, ultimate and proximate analysis-heating and value grading of coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas-calorific value.
- (c) Chemical chemistry: Composition of blood collection and preservation of samples. Clinical analysis, serum electrolytes, blood glucose, blood urea, nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphatases. Immunoassay: principles of radioimmunoassay (RIA) and applications. The blood gas analysis trace elements in the body.
- (d) Drug analysis: Narcotic and dangerous drugs. Screening by gas and thin layer chromatography and (spectrophotometric) measurements.

Books suggested

Semester- IV

Paper II

Inorganic Polymers

UNIT- I

1. Analytical chemistry, G.D. Christian, J. Wiley.
2. Fundamentals of analytical chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
3. Analytical chemistry principles, J.S. Kennedy, W.B. Saunders.
4. Analytical chemistry principles and techniques, L.G. Hargis, Prentice Hall.
5. Principles of instrumental analysis, D.A. Skoog, J.L. Loary X.B. Saunders.
6. Principles of instrumental analysis, D.A. Skoog, W.B. Saunders.
7. Quantitative analysis, R.A. Day Jr and A.L. Underwood, Prentice Hall.
8. Environmental solution analysis, S.M. Khopkar Wiley Eastern.
9. Basic concepts of analytical chemistry, S.M. Khopkar, Wiley Eastern.
10. Handbook of instrumental techniques for analytical chemistry, F. Settle, Prentice Hall.

Basics

Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization.

Linear, branched and network polymers, Classification of polymers Polymerization: condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

UNIT- II

Polymer Characterization

Polydispersion-average molecular weight concept. Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights. End group,

viscosity, light scattering, osmotic and ultracentrifugation methods. Analysis and testing of polymers. Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study. Microscopy. Thermal analysis and physical testing-tensile strength. Fatigue, impact, tear resistance. Hardness and abrasion resistance.

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UNIT- III

Structure and Properties

Morphology and order in crystal fine polymers-configurations of polymer chains. Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting point T_m -melting points of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, T_g -Relationship between T_m and T_g , Effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.

UNIT- IV

A-Polymer Processing

Plastics, elastomers and fibers Compounding Processing techniques Calendering diecasting, rotational casting film casting injection moulding. blow moulding. extrusion moulding thermolforming, foaming, reinforcing and fibre spinning.

B- Properties of Commercial Polymers

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Polyethylene, Polyvinyl chloride polyamides polyesters, phenolic resins. epoxy resins and silicone polymers. Functional polymers, fire retarding polymers and electrically conducting polymers. Biomedical polymers-contact lens, dental polymers, artificial heart. kidney, skin and blood cells.

Books Suggested

1. Textbook of Polymer Science, F.W. Billmeyer Jr. Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and I Sreedhar, Wiley-Eastern.
3. Functional Monomers and Polymers. K. Takemoto, Y. Inaki and RM. Rttanbrite.
4. Contemporary Polymer Chemistry, HR. Alcock and F.W. Lambe, Prentice Hall.
5. Physics and Chemistry of Polymer, I.M.G. Cowie, Blackie Academic and Professional

Semester- IV
Elective Paper III

Organic Synthesis-I
UNIT- I

Organometallic reagents

Principles, preparations, properties and applications of the following in organic synthesis with mechanistic details.

- A. Group I and II metal organic compounds
Li, Mg, Hg, Cd, Zn compounds.
- B. Transition metals
Cu, Pd, Ni, Fe, Co, Ti compounds.

UNIT- II

A-Oxidation

Introduction different oxidative processes.

Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acid.

Amines, hydrazines and sulphides.

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

B- Reduction

Introduction, different reductive processes.

Hydrocarbons-alkanes, alkynes and aromatic rings.

Carbonyl compound-aldehydes, ketones, acids and their derivatives. Epoxides.

Nitro, nitroso, azo and oxime groups. Hydrogenolysis.

UNIT- III

Rearrangements

General mechanistic consideration: nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements

Pinacol-pinacolone, wagner-meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Aamdt-Eistert synthesis, Neber, Beckmann, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction.

UNIT- IV

Metalloenes, Nonbenzenoid Aromatic and polycyclic aromatic compound

General consideration, synthesis and reactions of some representative compounds.

Books suggested

1. Modern synthetic reactions, H.O. House, W.A. Benjamin.
2. Some modern methods of organic synthesis, W. Carruthers, Cambridge Univ. Press.
3. Advanced organic chemistry, reactions mechanisms and structure, J. March, John Wiley.
4. Principles of organic synthesis, R.O.C. Norman and J.M. Coxon, Blackie academic and professional.
5. Advanced organic chemistry part B, F.A. Carey and R.J. Sundberg. Plenum Press.
6. Rodd's chemistry of carbon compounds, Ed. S. Coffey Elsevier.

Semester- IV
Elective Paper IV
Organic Synthesis II

UNIT-I

Disconnection approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group interconversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amino synthesis.

UNIT- II

A-Protecting groups

Principle of protection of alcohols, amino, carbonyl and carboxyl groups.

B-one group C-C disconnections

Alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

UNIT-III

Two group C-C disconnections

Diels-Alder reaction, 1,3-disubstituted compounds, $\alpha\beta$ unsaturated carbonyl compounds control in carbonyl condensations, 1,5-disubstituted compound. Michael addition and Robinson annelation.

UNIT – IV

Ring synthesis

Saturated heterocycles, synthesis of 3,4,5 and 6 membered rings, aromatic heterocycles in organic synthesis.

Synthesis of some complex molecules :

Application of the above in the synthesis of following compounds: camphor, longifoline, cortisone, reserpine, vitamin D, juvabione, aphidicolin and fredericamycin A.

Books suggested

1. Designing organic synthesis, S. Warren, Wiley.
2. Organic synthesis-concept methods and starting materials, J. Fuhrhop and G. Penzillin, verlage VCR
3. Some modern methods of organic synthesis, W. Carruthers, Cambridge Univ. Press.
4. Modern synthetic reactions, H.O. House, W.A. Benjamin.
5. Advanced organic chemistry: reactions mechanism and structure, J. March, Wiley.
6. Principles of organic synthesis, R Norman, J.M. Coxon, Blackie academic and professional.
7. Advanced organic chemistry part B. F.A. Carey and R J. Sundberg, Plenum press.