M. Sc. CHEMISTRY
CODE 321 & 322

SEMESTER EXAMINATION
2014-2016

EXAMINATION SCHEME

M.Sc. examination will be conducted in four SEMESTERS. Each semester exam shall consist of FOUR THEORY PAPERS AND TOW LAB COURSES.

SEMESTER – I (20 CREDIT)

THEORY (16 CREDIT)

PAPER	COURSE	CREDIT	DURA-TION	INTERNAL ASSESSMENT	THEORY MARKS	TOTAL MARKS
CH – 1	GROUP THEORY AND CHEMISTRY OF METAL COMPLEXES	4	3 Hrs	20	80	100
CH - 2	CONCEPTS IN ORGANIC CHEMISTRY	4	3 Hrs	20	80	100
CH - 3	QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - I	4	3 Hrs	20	80	100
CH - 4	THEORY AND APPLICATIONS OF SPECTROSCOPY-I	4	3 Hrs	20	80	100

PRACTICAL (4 CREDIT)

PAPER	COURSE	CREDIT	DURATION	MARKS
CH - 5	Lab Course - I	2	8 Hrs	100
CH - 6	Lab Course - II	2	8 Hrs	100

SEMESTER – II (20 CREDIT)

THEORY (16 CREDIT)

PAPER	COURSE	CREDIT	DURA-TION	INTERNAL ASSESSMENT	THEORY MARKS	TOTAL MARKS
CH - 7	TRANSITION METAL COMPLEXES	4	3 Hrs	20	80	100
CH - 8	REACTION MECHANISMS	4	3 Hrs	20	80	100
CH - 9	QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - II	4	3 Hrs	20	80	100
CH - 10	THEORY AND APPLICATIONS OF SPECTROSCOPY-II	4	3 Hrs	20	80	100

PRACTICAL (4 CREDIT)

PAPER	COURSE	CREDIT	DURATION	MARKS
CH - 11	Lab Course - III	2	8 Hrs.	100
CH - 12	Lab Course - IV	2	8 Hrs.	100

SEMESTER – III (20 CREDIT)

THEORY (16 CREDIT)

PAPER	COURSE	CREDIT	DURA-TION	INTERNAL ASSESSMENT	THEORY MARKS	TOTAL MARKS
CH - 13	RESONANCE SPECTROSCOPY AND PHOTOCHEMISTRY	4	3 Hrs	20	80	100
CH - 14	CHEMISTRY OF BIOMOLECULES	4	3 Hrs	20	80	100
CH - 15	CATALYSIS, SOLID STATE AND SURFACE CHEMISTRY	4	3 Hrs	20	80	100
CH - 16	ANALYTICAL TECHNIQUES AND DATA ANALYSIS	4	3 Hrs	20	80	100

PRACTICAL (4 CREDIT)

PAPER	COURSE	CREDIT	DURATION	MARKS
CH - 17	Lab Course - V	2	8 Hrs.	100
CH - 18	Lab Course - VI	2	8 Hrs.	100

SEMESTER – IV (20 CREDIT)

THEORY (16 CREDIT)

PAPER	COURSE	CREDIT	DURA-TION	INTERNAL ASSESSMENT	THEORY MARKS	TOTAL MARKS
CH - 19	INSTRUMENTAL METHODS OF ANALYSIS	4	3 Hrs	20	80	100
CH - 20	MEDICINAL CHEMISTRY	4	3 Hrs	20	80	100
CH - 21	MATERIAL AND NUCLEAR CHEMISTRY	4	3 Hrs	20	80	100
CH - 23	APPLIED CHEMICAL ANALYSIS	4	3 Hrs	20	80	100

PRACTICAL (4 CREDIT)

PAPER	COURSE	CREDIT	DURATION	MARKS
CH - 17	Lab Course - VII	2	8 Hrs.	100
CH - 18	Lab Course - VIII	2	8 Hrs.	100

SCHEME FOR PRACTICAL EXAMINATION

EXPERIMENT	MARKS
Major Experiment	30
Minor Experiment - 1	15
Minor Experiment - 2	15
Viva-voce	20
Sessional Marks	20
TOTAL MARKS	**100**

FIRST SEMESTER
PAPER NO. CH – 1
GROUP THEORY AND CHEMISTRY OF METAL COMPLEXES

Max. Marks 80

UNIT – I **SYMMETRY AND GROUP THEORY IN CHEMISTRY:** Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schonflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use; spectroscopy.

UNIT – II

A. METAL-LIGAND BONDING: Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, bonding and molecular orbital theory.

B. 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 – III

A. METAL–LIGAND EQUILIBRA IN SOLUTION: Stepwise and overall formation onstants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexs 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.

B. ISOPOLY ACID AND HETEROPOLYACID: Isopoly and heteropoly acids of Mo and W. Preparation, properties and structure. Classification, Preparation, properties and structures of borides,carbides, nitrides and silicides. Silicates-classification and Structure, Silicones-preparation, properaties and application.

UNIT – IV

A. METAL CLUSTERS: Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbnonyl and halide cluster, compounds with metal-metal multiple bonds.

B. CHAINS: catenation, heterocatenation, intercatenation.

C. RINGS: Borazines, phosphazines.

BOOK SUGGESTED:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes and Row.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.

6. Comprehensive Coordination Chemistry Eds. G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.

PAPER NO. CH – 2
CONCEPTS IN ORGANIC CHEMISTRY

Max. Marks 80

UNIT - I

A. NATURE OF BONDING IN ORGANIC MOLECULES: Localized and Delocalized chemical bod, conjugation and cross-conjugation, Bonding in Fullerenes, Bonds weaker than covalent, addition compounds, Crown ether complexes and cryptands. Inclusion compounds, Cyclodextrins, Catenanes and Rotaxanes.

B. AROMATICITY: Aromaticity in benzonoid and non-benzenoid compounds, Huckel's rule, annulenes, anti-aromaticity, homo-aromaticity. PMO approach for Aromaticity, Annulenes.

UNIT – II

A. CONFORMATIONAL ANALYSIS: Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.

B. STEREOCHEMISTRY: Elements of symmetry, chirality, molecules with more than one chiral center, methods of resolution, optical purity, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon (Biphenyls, allenes and spiranes), chirality due to helical shape.

UNIT - III

A. REACTION INTERMEDIATES: Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Sandmeyer reaction, Free radical rearrangement and Hunsdiecker reaction.

B. ELIMINATION REACTIONS: The E_2, E_1 and E_1cB mechanisms. Orientation of the double bond. Reactivity,effects of substrate structures, attacking base, the leaving group and the medium.

UNIT - IV **PERICYCLIC REACTIONS:** 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 - antrafacial and suprafacial additions, 4n and 4n+2 system, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements-suprafacial and antarafacial shifts of H, sigmatrophic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and Aza-Cope rearrangements. Ene reaction.

BOOKS SUGGESTED:

1. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
2. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
3. Structures and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
4. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
5. Modern Organic Reactions, H. O. House, Benjamin.
6. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackle Academic and Professional.
7. Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillian.
9. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
10. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
11. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
12. Organic Chemistry, Vol 2, I. L. Finar, ELBS.

13. Stereo selective Synthesis: A Practical Approach, M. Nogradi, and VCH.
14. Organic Chemistry, Paula Yurkanis Bruice, Pearson Education.

PAPER NO. CH – 3
QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - I

Max. Marks : 80

UNIT – I

A. MATHEMATICAL CONCEPT IN QUANTUM CHEMISTRY : Vector quantities and their properties Complex numbers and Coordinate transformation. Differential and Integral Calculus, Basis rules of differentiation and Integration Applications.

B. The Schrodinger equation and postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz Particle in a box the harmonic oscillator, the rigid rotator, the hydrogen atom.

UNIT –II **BASICS OF THERMODYNAMICS:** Maxwell's thermodynamic relations and its applications. Reaction isotherm, Vant's Hoff hypothesis. Partial molar properties; Partial molar free energy, partial molar volume and partial molar heat content. Chemical potential, Gibbs Duhem equation, variation of chemical potential with temperature and pressure. Chemical potential of ideal gases, pure solids, liquids and mixture of ideal gases. Activity and Fugacity, Determination of Fugacity, Variation of Fugacity with Temperature and Pressure.

UNIT – III **ELECTROCHEMISTRY–I:** Electrochemistry of solution. Debye-Huckel Onsager treatment and its extension, ion solvent interactions. Debey-Huckel-Limiting Law. Debye-Huckel theory for activity coefficient of electrolytic solutions. Determination of activity and activity coefficient, ionic strength, Thermodynamics of electrified interface equations. Derivation of electro-capillarity, Lippmann equation (surface excess), methods of determination.

UNIT – IV **CHEMICAL DYNAMICS – I:** Methods of determining rate laws, consecutive reactions, collision theory of reaction rates, steric factor, Activated complex theory, kinetic salt effects, steady state kinetics, and thermodynamic and Kinetic control of reactions. Dynamic chain (Hydrogen-bromine and Hydrogen-chlorine reactions) and Oscillatory reactions (Belousov-Zhabotinsky reaction)

BOOKS SUGGESTED :

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Coulson's Valence, R. McWeeny, ELBS.
3. Chemical Kinetics, K. J. Laidler, Pearson.
4. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
5. Modern Electrochemistry Vol. I and Vol. II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
6. Thermodynamics for Chemists, S. Glasstone EWP.
7. An Introduction to Electrochemistry S. Glasstone EWP.
8. Organic Chemist's Book of Orbitals. L. Salem and W.L. Jorgensen, Academic Press
9. The Physical Basis of Organic Chemistry, H. Maskill, Oxford University Press

PAPER NO. CH - 4
THEORY AND APPLICATIONS OF SPECTROSCOPY- I

Max. Marks : 80

UNIT – I **UNIFYING PRINCIPLES :** Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission transmission, reflection, dispersion, polarization and scattering, Uncertainty relation and natural line width and natural line broadening,

transition probability, results of the time dependent perturbation theory, transition moment selection rules intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels. Region of spectrum, representation of spectra, F.T. spectroscopy, computer averaging, lasers.

UNIT- II **MICROWAVE SPECTROSCOPY:**

Classification of molecules in term of their internal rotation mechanism, determination of rotation energy of diatomic and polyatomic molecules, intensities of rotational spectral lined, effect of isotopic substitution on diatomic and polyatomic molecules, intensities of rotational spectral lines and parameters of rotational energy of linear and the transition frequencies, non-rigid rotators, spectral lines and parameters of rotational energy of linear and symmetric top polyatomic molecules. Determination of bond length, application in structure elucidation.

UNIT- III **INFRA RED SPECTROSCOPY:**

Introduction, simple and anharmonic oscillators in vibrational spectroscopy, Modes of vibration in polyatomic molecules, vibration coupling, Fourier Transform IR spectroscopy: instrumentation, interferometric spectrophotometer, Non-dispersive photometers, Factors influencing vibrational frequencies, Application of IR spectroscopy: Interpretation of IR spectraof normal alkanes, aromatic hydrocarbons, alcohols and phenols aldehydes and ketones, eathers, esters, carboxylic acids and amines and amides.

UNIT- IV **RAMAN SPECTROSCOPY:**

Classical and quantum theories of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules mutual exclusion principle, Resonance Raman spectroscopy, Coherent anti Stokes Raman spectroscopy (CARS), Instrumentation , Application of Raman effect in molecular structures, Raman activity of molecular vibration, structure of CO_2, N_2O, SO_2, NO_3^-, ClF_3

BOOKS SUGGESTED

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Fundamentals of Molicular Spectroscopy, C.N. Banwell.
3. Spectroscopy, B.K. Sharma, Goel Publication.
4. Organic Spectroscopy: Principles and applications, Jag Mohan, Narosa Publication.
5. Spectroscopy methods in organic chemistry, D.H. Williams & I. Fleming, Tata Mcgraw-Hill Publication.
6. Spectrophometric identification of organic compounds, R.M. Silversteion & F. X. Webster, John Wiley Publication.

PAPER NO. CH - 5
LABORATORY COURSE – I

Max. Marks 100

1. QUALITATIVE ANALYSIS OF MIXTURE CONTAINING EIGHT RADICALS INCLUDING TWO LESS COMMON METAL FROM AMONG THE FOLLOWING BY SEMI MICRO METHOD.

1) *Basic Radicals :*
Ag, Pb, Hg, Bi, Cu, Cd, As, Sb, Sn, Fe, Al, Cr, Zn, Mn, Co, Ni, Ba, Sr, Ca, Mg, Na, K, Ce, Th, Zr, W, Te, Ti, Mo, U, V, Be, Li, Au, Pt.

2) *Acid Radicals :*
Carbonate, Sulphite, Sulphide, Nitrite, Nitrate, Acetate, Flouride. Chloride, Bromide, Iodide, Sulphate, Borate, Oxalate, Phosphate, Silicate, Thiosulphate, Ferrocyanide, Ferricyanide, Sulphocyanide, Chromate, Arsenate and Permanganate.

2. QUANTITATIVE ANALYSIS:

Involving separation of two of the following in ores, alloys, or mixtures in solution, one by volumetric and the other by gravimetric methods.

3. ESTIMATION OF:

1) Phosphoric acid in commercial orthophosphoric acid.
2) Boric acid in borax.
3) Ammonia in a ammonium salt.
4) Manganese dioxide in pyrolusite.
5) Available chlorine in bleaching powder.
6) Hydrogen peroxide in a commercial samples.

4. PREPARATIONS:-

Preparation of selected inorganic compound and their studies by I.R. electronic spectra, Mössbauer, E.S.R. and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds

(1) $VO(acac)_2$
(2) $TiO(C_9H_6NO)_2.2H_2O$
(3) cis-K $[Cr(C_2O_4)_2(H_2O)_2]$
(4) Na $[Cr(NH_3)_2(SCN)_4]$
(5) $Mn(acac)_3$
(6) $K_2[Fe(C_2O_4)_3]$
(7) Prussian Blue, Turnbull's Blue.
(8) $[Co(NH_3)_6][Co(NO_2)_6]$
(9) cis-$[Co(trien)(NO_2)_2]Cl.H_2O$
(10) Hg $[Co(SCN)_4]$
(11) $[Co(Py)_2Cl_2]$
(12) $[Ni(NH_3)_6]Cl_2$
(13) $Ni(dmg)_2$
(14) $[Cu(NH_3)_4]SO_4.H_2O$

BOOKS SUGGESTED

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.

PAPER NO. CH – 6
LABORATORY COURSE – II

Max. Marks 100

ADSORPTION/SURFACE CHEMISTRY

1. To Study Surface Tension - Concentration relationship for solutions (Gibbs equation).
2. To Verify the Freundlich and Langmuir Adsorption isotherms using acetic acid/Oxalic acid and activated charcoal.
3. Determination of CMC of surfactants.

PHASE EQUILIBRIA

1. To Construct the Phase diagram for three component system (e.g., chloroform-acetic acid-water).

CHEMICAL KINETICS

1. Determination of the effect of (a) Change of temperature (b) Change of concentration of reactants and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reactions.

2. Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
3. Determination of the rate constant for the decomposition of hydrogen peroxide by Fe^{+++} and Cu^{++} ions.
4. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).

SOLUTIONS/MOLECULAR WEIGHTS

1. Determination of molecular weight of non-volatile substances by Landsberger's Method.
2. Determination of Molar masses of Naphthelene/acetanilide by Rast's method.
3. Molecular weight of polymers by viscosity measurements.

CONDUCTOMETRY

1. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.
2. Determination of solubility and solubility product of sparingly soluble salts (e.g., $PbSO_4$, $BaSO_4$) conductometrically.
3. Determination of pK_a of Acetic acid and verification of Ostwald dilution law.

POTENTIOMETRY/pH METRY

1. Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
2. Determination of the dissociation constatnt of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
3. Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method.
4. Determination of Redox potential of Fe^{++}/Fe^{+++} system.

POLARIMETRY

1. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.
2. Enzyme kinetics – inversion of sucrose.
3. Determine the specific and molecular rotation of optically active substances.

BOOKS SUGGESTED

1. Experiments and Techniques in Organic Chemistry, D.Pasto, C. Johnson and M.Miller, Prentice Hall.
2. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
3. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
   Handbook of Organic Analysis – Qualitative and Quantitative, H. Clark, Adward Arnold.
4. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
5. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
6. Findley's Practical Physical Chemistry, B.P. Levitt, Longman.
   Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

SECOND SEMESTER

PAPER NO. CH - 7
TRANSITION METAL COMPLEXES

Max. Marks : 80

UNIT - I **REACTION MECHANISM OF TRANSITION METAL COMPLEXES:** Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect. 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, Correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states), Selection rules, mechanism for break down of the selection rules, intensity of absorption, band width, spectra of d-d metal complexes of the type $[M(H_2O)_n]^{n+}$, spin free and spin paired ML6 complexes of other geometries, Calculations of Dq, B and parameters, spin forbidden transitions, effect of spin-orbit coupling, Spectrochemical and Nephelouxetic series. Magnetic properties of complexes of various geometries based on crystal field model, spin free-spin paired equillibria in octahedral stereochemistry.

UNIT - III

A. TRANSITION METAL COMPLEXES: Tranisition metal complexes with unsaturated organic molecules, alkanes, allyl, diene dienyl, arene and trienyl complex, preparations, properties, nature of bonding and structure features. Imporant reaction relating to nucleophilic and electrophilic attack on ligands and organic synthesis.

B. TRANSITION METALS COMPOUND WITH BOND TO HYDROGEN: Transition Metals Compound with Bond to Hydrogen.

UNIT-IV

A. ALKYLS AND ARYLS OF TRANSITION METALS: Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

B. COMPOUNDS OF TRANSITION METAL - CARBON MULTIPLE BONDS : Alkylidenes, low valent carbenes nature of bond and Structural characteristics.

C. FLUXIONAL ORGANOMETALLIC COMPOUNDS: Fluxionality and dynamic equilibria in compounds such as olefin, -allyl and dienyl complexes.

BOOKS SUGGESTED :

1. Pinciples and application of organotransition metal chemistry, J.P.Collman, L.S.Hegsdus, J. R. Norton and R.G. Finke, University Science Books.
2. The Organometallic chemistry of the Transition metals, R. H. Crabtree, John Wiley.
3. Metallo - organic chemistry, A.J. Pearson, Wiley.
4. Organometallic chemistry, R. C. Mehrotra and A.Singh, New age International.

PAPER NO. CH - 8
REACTION MECHANISMS

Max. Marks : 80

UNIT - I **A. ALIPHATIC NUCLEOPHILIC SUBSTITUTION:** The S_N2, S_N1, mechanisms.The neighbouring group mechanism, neighbouring group

participation by π and σ bonds, anchimeric assistance. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, ambident nucleophile and regioselectivity.

B. **AROMATIC NUCLEOPHILIC SUBSTITUTION:** The S_NAr, S_N1, and benzyne mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

UNIT – II A. **ALIPHATIC ELECTROPHILIC SUBSTITUTION:** Mechanisms of- S_E2 S_E1, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

B. **AROMATIC ELECTROPHILIC SUBSTITUTION:** The arenium ion mechanism, orientation and reactivity. The ortho/para ratio, iso attack, orienation in other ring systems.o Reactivity- Effect of substrates and electrophilles. Vilsmeir reaction and Gattermann-Koch reaction.

UNIT - III **ADDITION TO CARBON-CARBON MULTIPLE BONDS:** Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings Hydroboration, Micheal reaction. Shrapless asymetric epoxdation.

UNIT – IV **ADDITION TO CARBON-HETERO MULTIPLE BONDS:** Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids esters and nitriles.Addition of Grignard Reagents, Organo-Zinc and Organo-lithium to carbonyls and unsaturated carbonyl compounds, Wittig reaction.
Mechanism of condensation reactions involving enolates - Aldol, Knoevenagel and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

BOOKS SUGGESTED :

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March,Johan Wiley.
2. Modern Organic Reactions, H. O. House, Benjamin.
3. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackle Academic & Professional.
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structures and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
6. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillian

PAPER NO. CH – 9
QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - II

Max. Marks : 80

UNIT – I A. **APPLICATION OF MATRICES IN QUANTUM CHEMISTRY :** Addition and multiplication, inverse and transpose of matrices. Determinants, in quantum Chemistry.

B. **ANGULR MOMENTION IN QUANTUM CHEMISTRY:** Angular momentum, angular momentum Operators. Eigen functions and Eigen values Angular momentum, ladder operators.

C. **APPROXIMATE METHODS:** The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Applications of variation method and perturbation theory to the Helium atom.

NIT – II **STATISTICAL THERMODYNAMICS :** Probability, permutations and combinations concepts of probability, Maxwell Boltzmann distribution. Different ensembles and Partition functions translational, rotational, vibrational and Electronic. Thermodynamic function using appropriate Partition function. Fermi-Dirac and Bose-Einstein Statistics and statistical basis of entropy. Heat capacity of solids Debye and Einstein Models.

NIT – III **ELECTROCHEMISTRY – II:** Structure of electrified interfaces. Gouy-Chapman, Stern, Over potentials and exchange current density, Derivation of Butler – Volmer equation, Tafel plot. Semiconductor interfaces, Theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interfaces. Electro catalysis influence of various parameters. Hydrogen electrode.

NIT – IV **CHEMICAL DYNAMICS – II:** General features of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motions, probing the transition state, dynamics of barrier less chemical reactions in solutions, dynamics of unimolecular reaction. [Lindemann – Hinshelwood and Rice-Ramsperger-Kassel-Marcus {RRKM}] theories of unimolecular reactions.

OOKS SUGGESTED :

The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
Mathematics for Chemistry, Doggett and Sutclilffe, Longman.
Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
Chemical Mathematics, D.M, Hirst, Longman.
Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
Basic Mathematics for Chemists, Tebbutt, Wiley.
Physical Chemistry, P.W. Atkins, ELBS.
Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
Quantum Chemistry, Ira N. Levine, Prentice Hall.
Coulson's Valence, R. McWeeny, ELBS.
Chemical Kinetics, K. J. Laidler, Pearson.
Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
Modern Electrochemistry Vol. I and Vol. II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
Thermodynamics for Chemists, S. Glasstone EWP.
An Introduction to Electrochemistry S. Glasstone EWP.
Physical Chemistry, Ira N. Levine McGraw Hill.
Physical Chemistry, Silbey, Alberty, Bawendi, John-Wiley.

PAPER NO. CH - 10
THEORY AND APPLICATIONS OF SPECTROSCOPY – II

Max. Marks : 80

IT – I **ULTRAVIOLET AND VISSIBLE SPECTROSCOPY:**
Introduction, intensity of vibrational-electronic spectra and Frank Condon principle for dissociation enegy, rotational fine structure of electronic-vibrational spectra, Shape of some molecular orbitals viz, H2, He2, N2, O2. Electronic spectra of organic molecules chromophores, application of electronic spectroscopy: spectrophotometric studies of complex ions, determination of ligand/metal ratio in a complex, identification of compounds, determination stability constants.

UNIT – II **SCATTERING SPECTROSCOPY :**

Principle, instrumentations and application of Auger spectroscopy and scanning electron microscopy for chemical characterization, electron diffraction of gases and vapours, The Wieri equation and co-related method, application of electron diffraction.

Theory, instrumentation and application of turrbidimetry, nephelometry and fluorometry. Fluoroscence and phosphorescence and factors affecting them.

UNIT – III **MASS SPECTROMETRY :**

Introduction, basic principles, separation of the ions in the analyzer, resolution, molecular ion peak, mass spectral fragmentation of organic compounds, factors affecting fragmentation, McLafferty rearrangement. Instrumentation, Characteristics of mass spectra of Alkanes, Alkanes, Aromatic hydrocarbons, Alcohols, amine. Nitrogen rule, ring rule, Molecular weight and formula determination, Gas chromatography-mass spectrophotometry: Introduction.

UNIT – IV **NUCLEAR RESONANCE SPECTROPHOTOMETRY :**

Theory of NMR spectroscopy, interaction of nuclear spin and magnetic moment, chemical shift, processional motion of nuclear particles in magnetic field, spin-spin splitting, coupling constants, factor affecting the chemical shift, shielding effect, effect of chemical exchange, hydrogen bonding, instrumentation of Fourier transform NMR spectrophotometer, structure determination of organic compounds, Carbor-13 NMR spectroscopy, Multiplicity-proton (^{1}H) decoupling-noise decoupling, off resonance decoupling, selective proton decoupling, chemical shift.

BOOKS SUGGESTED

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Fundamentals of molecular Spectroscopy, C.N. Banwell.
3. Spectroscopy, B.K. Sharma, Goel Publication.
4. Organic Spectroscopy : Principles and Application, Jag Mohan, Narosa Publication.
5. Spectroscopic methods in organic chemistry, D.H. Williams & I. Fleming, Tata Mcgraw-Hill Publication.
6. Spectrophometric identification of organic compounds, R.M. Silverstein & F.X. Webster, John Wiley Publications.

PAPER NO. CH - 11
LABORATORY COURSE – III

1. **GENERAL METHODS OF SEPARATION AND PURIFICATION OF ORGANIC COMPOUNDS WITH SPECIAL REFERENCE TO:** **Max. Marks : 80**
   1) Solvent Extraction
   2) Fractional Crystallisation
2. **DISTILLATION TECHNIQUIES:**
   Simple distillation, steam distillation, Fractional distillation and distillation under reduced pressure.
3. **ANALYSIS OF ORGANIC BINARY MIXTURE:**
   Separation and Identification of organic binary mixtures containing at least one component with two substituents.
   (A student is expected to analyse at least 10 different binary mixtures.)
4. **PREPARATION OF ORGANIC COMPOUNDS: SINGLE STAGE PREPARATIONS.**
   1) **Acetylation:** Synthesis of β -Naphthyl acetate from β -Naphthol / Hydroquinone diacetate from Hydroquinone.
   2) **Aldol condensation:** Dibenzal acetone from benzaldehyde
   3) **Bromination:** p-Bromoacetanilide from acetanilide.
   4) **Cannizzaro Reaction:** Benzoic acid and Benzyl alcohol from benzaldehyde.
   5) **Friedel Crafts Reaction:** O-Benzoyl Benzoic acid from phthalic anhydride.
   6) **Grignard Reaction:** Synthesis of triphenylmethanol from benzoic acid,
   7) **Oxidation:** Adipic acid by chromic acid oxidation of cyclohexanol.
   8) **Perkin's Reaction:** Cinnamic acid from benzaldehyde.
   9) **Sandmeyer Reaction:** p-Chlorotoluene from p-toluidine/o-Chlorobenzoic acid from anthranilic acid.
   10) **Schotten Baumann Reaction:** β -Naphthyl benzoate from:β-Naphthol / Phenyl benzoate from phenol.
   11) **Sulphonation Reaction:** Sulphanilic acid from aniline.

BOOK SUGGESTED :

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.
3. Practical Organic chemistry by Garg and Salija.
4. The Systematic Identification of Organic compounds, R. L. Shriner and D. Y. Curtin.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J. B. Entrikin and E. M. Hodnett.
6. Practical Physical chemistry by Alexander Findlay,
7. Experimental Physical chemistry, D. P. Shoemaker, G. W. Garland and J. W. Niber, Mc Graw Hill Interscience.
8. Findlay's Practical Physical chemistry, revised B. P. Levitt, Longman.

PAPER NO. CH – 12
LABORATORY COURSE – IV

I. **ERROR ANALYSIS AND STATISTICAL DATA ANALYSIS** **Max. Marks 100**
   1. Linear Regression Analysis
   2. Curve Fitting
   3. Student "t" Test
   4. Data Analysis Using Basic Statistical Parameters
   5. Calibration of volumetric Apparatus, Burette, Pipette Weight Box etc.

II. **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 student will operate one or two or the packages such as MICROSOFT ECXEL, WORLD, POWERPOINT, SPSS, ORIGIN, MATLAB, EASYPLOT.

III. **A. FLAME PHOTOMETRIC DETERMINATIONS**
   1. Sodium and potassium when present together.
   2. Sodium/potassium in solid samples.
   3. Solid Sodium and Potassium in Liquid Samples.
   4. Lithium/calcium/barium/strontium.
   5. Cadmium and magnesium in tap water.

B. NEPHELOMETRIC DETERMINATIONS
   1. Sulphate
   2. Phosphate
   3. Silver

IV. ELECTROPHORESIS

1. To separate cations of inorganic salts by paper electrophoresis.
2. Capillary Electrophoresis of water – soluble Vitamines

V. SPECTROSCOPY

1. Verification of Beer's Lambert Law.
2. Determination of stoichiometry and stability constant of inorganic (e.g. ferric salicylclic acid) and organic (e.g. amine-iodine) complexes, thiocynam.
3. Characterization of the complexes by electronic and IR, UV spectral data.
4. Determination of Indicator constant (pK_a) of methyl red.

BOOK SUGGESTED :

1. Computer and Common Sense, R. Hunt and J. Shelley, Prentice Hall.
2. Computational Chemistry, A.C. Norris.
3. Microcomputer Quantum Mechanics, J.P. Killngbeck, Adam Hilger.
4. Computer Programming in FORTRAN IV, V. Rajaraman, Prentice Hall.
5. An Introduction to Digital Computer Design, V. Rajaraman and T. Radhakrishnan, Prentic Hall.
6. Experiments in Chemistry, D.V. Jahagirgar.

THIRD SEMESTER

PAPER NO. CH - 13
RESONANCE SPECTROSCOPY AND PHOTOCHEMISTRY

Max. Marks : 8

UNIT – I

A. ELECTRON SPIN RESONANCE SPECTROSCOPY : Hyperfine coupling, spi polarization for atoms and transition metal ions, spin-orbit coupling an significance of g-tensors, application to transition metal complexes (having on unpaired electron).

B. NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY: Quadrupol nuclei, quadrupole moments, electric field gradient, coupling constan splittings, applications.

UNIT – II

A. PHOTOELECTRON SPECTROSCOPY : Basic principle both for atoms an molecules; Photo-electric effect, ionization process, Koopman's theorem photoelectron spectra of simple molecules, Auger electron spectroscop Determination of Dipole moment.

B. PHOTOACOUSTIC SPECTROSCOPY: Basic principle of Photo acousti Spectroscopy (PAS), PAS – gases and condensed system Chemical an Surface application.

UNIT – III

A. PHOTOCHEMICAL REACTIONS : Interaction of electromagnetic radiatio with matter, Stern Volmer equation, types of excitations, fate of excite molecule, quantum yield, transfer of excitation energy, Actinometry.

B. DETERMINATION OF REACTION MECHANISM: Classification, rat constatnts and life times of reactive energy states – determination of rat constants of reactions. Effect of light intensity on the rate of photochemica reactions.

C. MISCELLANEOUS PHOTOCHEMICAL REACTIONS : Photo-Fries reaction of anilides, Photo-Fries rearrangement. Barton reaction. Singlet molecul

oxygen reactions. Photochemical formation of smog. Photodegradation of polymers, Photochemistry of vision.

UNIT – IV

A. PHOTOCHEMISTRY OF ALKENES : Intramolecular reation of the olefinic bond – geometricalisomerism, cyclisation reactions, rearrangement of 1,4- and 1,5- dienes.

B. PHOTOCHEMISTRY OF CARBONYL COMPOUNDS : Intramolecular reactions of carbonyl compounds. Cyclohexadienones. Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

C. PHOTOCHEMISTRY OF AROMATIC COMPOUNDS: Isomerisations, additions and substitutions.

BOOK SUGGESTED:

1. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
2. Fundamentals of Photochemsitry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
3. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Scientific Publications.
4. Molecular Photochemsitry, N.J. Turro, W.A. Benjamin.
5. Introductory Phtochemistry, A. Cox and T. Camp, McGraw-Hill.
6. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
7. Application of Spectroscopy of Organic Compounds, J.R. Dyer, Prentice Hall.
8. Photochemistry , R.P. Kundall and A. Gilbert, Thomson Nelson.
9. Organic Photochemistry, J. coxon and B. Halton, Cambridge University Press.

PAPER NO. CH - 14
CHEMISTRY OF BIOMOLECULES

Max. Marks : 80

UNIT – I

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

B. ELECTRON TRANSFER IN BIOLOGY: Structure and function of metalloproteins in electron transport processes – cytochromes and ion-sulphur proteins, synthetic models.

C. TRANSPORT AND STORAGE OF DIOXYGEN: Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, haemocyanins and haemerythrin, model synthetic complexes of iron, cobalt and copper.

UNIT – II

A. METALLOENZYMES: Zinc enzymes – carboxypeptibase and carbonic anhydrase. Iron enzymes – catalase, peroxidase and cytochrome P-450. copper enzymes- superoxide dismutase. Molybdenum oxatransferase enzymes – xanthine oxidase.

B. ENZYME MODELS: Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, Cyclodextrin-based enzyme models, calixarenes, ionophores, synthetic enzymes or synzymes.

UNIT – III

A. ENZYMES : Nomenclature and classification of Enzyme. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors.

B. CO-ENZYME CHEMISTRY: Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, vitamin B_{12}.

C. **BIOTECHNOLOGICAL APPLICATIONS OF ENZYMES:** Tehcniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilization enzymes in medicine and industry. Enzymes and Recombinant DNA Technology.

UNIT – IV A. **BIOPOLYMER INTERACTIONS:** forces involved in biopolymer interaction. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves.

B. **THERMODYNAMICS OF BIOPOLYMER SOLUTIONS**: Thermodynamics of biopolymer solution, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechnochemical system.

C. **CELL MEMBRANE AND TRANSPORT OF IONS**: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport and Nerve conduction.

BOOK SUGGESTED:

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.L. Lippard and J.S. Valentine, University Science Books.
3. Inorganic Biochemistry vols II and I.Ed G.L. Eichhorn, Elservier.
4. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
5. Bioinorganic Chemistry, I. Bertinin, H.B. Gary, S.J. Lippard and J.S. Valentine, University Science.
6. Inorganic Biochemistry vols I and II ed. G.L. Eichhorn, Elsevier.
7. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-verlag.
8. Understanding Enzymes, Trevor palmer, Prentice Hall.
9. Enzyme Chemistry : Impact and Applications, Ed. Collin J Suckling, Chapman and Hall.
10. Enzyme Mechanisms Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
11. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
12. Immobilizaed Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, and John Wiley.
13. Enzymatic Reaction Mechanisms, C. Walsh, W.H. Freeman.
14. Enzyme Structure and Mechanisms, A Fersht, W.H. Freeman.
15. Biochemistry: The Chemical Reacitons of liging cells, D.E. Metzler, Academic Press.
16. Principles of Biochemistry, A.L. Lehninger, Wroth Publishers.
17. Biochemistry, L. Stryer, W.H. Freeman.
18. Biochemistry, J. David Rawn, Neil Patterson.
19. Biochemistry, Voet and Voet, John Wiley.
20. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.
21. Bioorganic Chemistry : A Chemistry Approach to Enzyme Action, H. Dugas and C. Penny, Springer-Verlag.
22. Biochemistry and Molecular Biology of Plants, Buchanan, Gruissem and Jones, I.K. International Pvt. Ltd.

PAPER NO. CH – 15
CATALYSIS, SOLID STATE AND SURFACE CHEMISTRY

Max. Marks : 80

UNIT – I **ACIDS, BASES, ELECTROPHILES, NUCLEOPHILES AND CATALYSIS :**
Acid-base dissociation, Electronic and structural effects, acidity and basicity. Acidity function and their applications. Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The α-effect. Ambivalent Nucleophilies. Acid base catalysis-specific and general catalysis. Bronsted catalysis, Enzyme Catalysis.

UNIT – II **MICELLES AND ADSORPTION :**
Micelles : Classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of Surfactants. Thermodynamics of micellization - phase separation and mass action models. Reverse micells, micro-emulsion. Micellar Catalysis, Surface tension capillary action, pressure difference across curved surface (Laplace equation), vapor pressure of droplets (Kelvin equation), Gibbs adsorption isotherm.

UNIT – III **SOLID STATE CHEMISTRY - I :**
Crystal defects and Non-stoichiometry - Perfect and imperfect crystals, intrinsic and extrinsic defects - point defect, line and plane defects, vacancies - Schotty defects and Frankel defects. Thermodynamics of Schotty and Frenkel defect, formation of color centres, non-stoichiometry and defects. Electronic properties and Band theory of semiconductors.

UNIT – IV **MACROMOLECULES :**
Polymer - Definition types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization.
Molecular mass, average molecular mass molecular mass determination (Osmometry, Viscometry, diffusion and light scattering methods), Sedimentation, chain configuration of macromolecules calculation of average dimensions of various chain structures.

BOOK SUGGESTED :

1. G.W. Castellan, "Physical Chemistry", Addison- Lesley Publishing Co.
2. E.A. Moelwyn Hughes, "Physical Chemistry", Pergamon Press.
3. Denbigh, "Chemical Equilibria", D. Van Nostrand.
4. J. Rose, "Dynamic Physical Chemistry" Sir Issac Pitman and Sons.
5. Solid state "Chemistry and its Applications, A.R. West, Plenum.
6. Principle of Solid State H.V. Kar, Wiley Eastern.
7. Solid State Chemists, D.K. Chakrabarty, New Age International (P) Ltd.
8. Micelles, Theoretical and Applied Aspects, V. Moral Plenum.
9. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
10. Mathematics for Chemistry, Doggett and Sutcliffe, Longman.
11. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
12. Chemical Mathematics, D.M. Hirst, Longman.
13. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
14. Basic Mathematics for Chemists, Tebbutt, Wiley.
15. Quantum Chemistry, Ira N. Levine, Prentice Hall.
16. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.

PAPER NO. CH – 16
ANALYTICAL TECHNIQUES AND DATA ANALYSIS

Max. Marks : 80

UNIT – I SAMPLE PREPARATION, DEGESTION AND STATISTICAL ANALYSIS

A. Sampling - Collection, Preservation and preparation of sample, Techniques of sampling solids, liquids and gases, Operation of drying and preparing a solution of the analyte.
Principle, methodology and application of different types of digestions such as aid digestion, base digestion, enzymatic and microwave digestion for liquid and solid materials.

B. Evolution and procession of Analytical Data, Precision and Accuracy. Types of Errors, Normal Distribution Curve, Standard deviation, Confidence limit Graphical presentation of result-method of average, Method of Liner lis square, Significant figures, Statistical aid to hypothesis testing-t-test, F-test Correlation coefficient, Rejection of data.

UNIT – II SEPARATION TECHNIQUES

A. Efficiency of extraction, Selectivity of extraction, Extraction system, Method o Extraction, applications.

B. Principals, classification of chromatographic techniques, Technique and applications of paper chromatographic, Thin-layer chromatographic, HPTLC Column chromatography.

UNIT – III THERMAL AND AUTOMATED METHODS

A. Principals, Instrumentation, Application of TGA, DTA and DSC methods.

B. Automated methods, Principle, instrumentation and application of flow injection analysis.

UNIT – IV ELECTROCHEMISTRY

A. Principals and instrumentation of pH potentiometry, coulometry and counductometry.

B. Basic principles, Diffusion current, polarized electrode, Micro electrode Dropping mercury Electrode Ilkovic equation, Polarographic wave, Qualitative analysisk Stripping methods, Cyclic Voltammetry, Amperometric titration curves, Differential pulse polarography and Square wave polarography.

BOOK SUGGESTED :

1. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M.
2. Saunders, College Publication.
3. Textbook of Quantitative Inorganic Analysis-Vogel A.I.
4. Principles and Practice of Analytical Chemistry-Fifield F.W and Kealey
5. D. Black well Science
6. Instrumental Analysis R. Braun, McGraw Hill, International Edition.
7. Analytical Chemistry, Christain, WSE/Wiley.
8. Instrumental Analysis, Willard Merilt, CBS.
9. Chemical Analysis, Brawn, McGraw Hill
10. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M.
11. Principles of instrumental analysis, Skoog Holler - Niemann.
12. Instrumental analysis, Wizard Dean and Merit.
13. Principal and PRACTICAL analytical chemistry, Fifield and Kealey.

PAPER NO. CH - 17
LABORATORY COURSE – V

Max. Marks 100

1. To determine the percent efficiency of given counter.
2. To calculate the activity with given radioactive source.
3. Determination of the half-life of Radionuclide.
4. Determination of absorption coefficient & half thickness of aluminum for β radiation.
5. Determination of absorption coefficient & half thickness of lead for gamma radiation.
6. Determination of range and energy of β particles.
7. Prove the inverse square law for gamma rays.
8. Measurement of gamma ray energy by gamma ray spectrometry.
9. Determination of the partition coefficient for iodine between carbon tetrachloride & (a) Water, (b) aqueous potassium iodide.
10. Study of kinetics of exchange between ethyl iodide & the iodide ion.
11. Determination of the solubility product of lead iodide.
12. Determination of the dissociation constant of Barium Nitrate.
13. Determination of the concentration of iodine in a given sample (KI), by isotope dilution technique.
14. To study the effect of temperature, concentration of the reactant and catalyst on the rate of a chemical reaction (Hydrolysis/Nucleophilic Substitution).
15. Reaction between Sodium Formate and Iodine by
    (i) Volumetric Method.
    (ii) Conductometric Method.
16. Saponification of ethyl acetate
    (i) Volumetric Method.
    (ii) Conductometric Method.
17. Reaction between Acetone and Iodine.
18. To study the autocatalylic reaction between $KMnO_4$ and Oxalic acid.
19. Reaction between $K_2S_2O_8$ and Iodine.
20. Determination of pKa by Kinetic Measurement.
21. Evaluation of Equilibrium constants from kinetic data.
22. Determination of rate constant of the decomposition of benzene diazonium chloride at different temperature.
23. To study the photolysis of uranyl oxalate.
24. To study the effect of substate catalyst etc (i) HCl, $K_2S_2O_8$ (ii) KOH, NaOH.
25. To study the Activation parameters.
26. To study the solvent effect using some Aprotic & Protic Solvents.
27. To examine the substituent effect (Hammett equation).
28. To study the effect of Electrolyte on the rate hydrolysis (KCl, NaCl,)
29. To study some simple enzyme catalyzed reaction.
30. To study the Micellar Catalyzed Reaction.

BOOK SUGGESTED :

1. Basic Experiment with radioisotopes by John, N. Andrews & David J. Hornsey, Pitam Publishing New York.
2. Practical radiochemistry by M.F.C. Ladd & W.H. Lee, Cleaver Hune press Ltd.
3. Practical Physical Chemistry by Alexander Findlay.
4. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, Mc Graw Hill Interscience.
5. Findlay's Practial Physical Chemistry, revised B.P. Levitt, Longman.

PAPER NO. CH – 18
LABORATORY COURSE – VI

Max. Marks 100

A. SPECTROPHOTOMETRIC DETERMINATIONS

I. Manganese / Chromium, Vanadium in steel sample.
II. Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive spectrophotometric method.
III. Fluoride / Nitrate / Phosphate.
IV. Iron – phenanthroline complex; Job's Method of continuous variations.
V. Zirconium – Alizarin Red – S complex: Mole-ratio method.
VI. Copper – Ethylene diamine complex: Slope-ratio method.

B. pH METRY

Stepwise proton-ligand and metal-ligand stability constant of complexes by Leving – Rossoti methods.

C. POLAROGRAPHY

Composition and stability constant of complexes.

D. FLAME PHOTOMETRIC DETERMINATIONS.

(i) Sodium and potassium when present together
(ii) Lithium / calcium / barium / strontium.
(iii) Cadium and magnesium in tap water.

E. REFRACTOMETRY

1. Determination the specific and molar refraction of a given liquid by abbe Refractometer.
2. Determine the variation of refractive index.
3. To verify law of refraction of mixture (glycerol + water).

F. SEPARATION AND QUANTITATIVE ESTIMATION OF BINARY AND TERNARY MIXTURES BY THE USE OF FOLLOWING SEPARATION TECHNIQUES:

1. Paper chromatography – Cadmium and Zinc, Zinc and Magnesium.
2. Thin – layer chromatography – separation of nickel, manganese, cobalt and zinc.
3. Ion-exchange.
4. Solvent extraction.
5. Electrophoretic separation.

BOOK SUGGESTED :

1. Quantitative Inorganic Analysis, A.I. Vogel.
2. Test book of quantitative chemical analysis, A.I. Vogel.
3. Practical Physical chemistry, A.M. James and F.E. Prichard, Longman.
4. Findley's Practical Physical Chemistry, B.P. Levitt. Longman.
5. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

FOURTH SEMESTER

PAPER NO. CH - 19
INSTRUMENTAL METHODS OF ANALYSIS

Max. Marks : 80

UNIT – I ADVANCED CHROMATOGRAPHY :

A. Ion chromatography : Ion exchange equilibrium, Ion-exchange packing and Inorganic Applications.

B. Size exclusion chromatography : Column packing, Theory of size of exclusion chromatography and applications.

C. Supercritical fluid chromatography : Properties of supercritical fluid SFC-Instrumentation and operating variables, comparison with other types of chromatography, applications.

D. Capillary Electrophoresis and capillary electro chromatography : overviews and applications

UNIT – II X-RAY AND PROTON INDUCED SPECTROSCOPY :

A. X-Ray fluorescent method : Principals-Characteristics x-ray emission. Instrumentation x-ray tube, Radioactive sources. Wavelength dispersive instruments.
Energy dispersive instruments. Analytical Applications-Qualitative Analysis.

B. Proton Induced X-Ray Spectroscopy : Theory, instrumentation and application.

UNIT – III ATOMIC EMISSION SPECTROSCOPY

A. Selectivity, sensitivity and interferences of atomic spectroscopy.

B. Theory, instrumentation and application of flame photometer, AES, ICP-AES and AFS.

UNIT – IV ATOMIC ABSORPTION SPECTROSCOPY AND HYPHENATED TECHNIQUES

A. Theory instrumentation and application of flame and graphite furnace AAS, cold-vapor and hydride generated AAS.

B. Theory , instrumentation and application of hyphenated techniques i.e. GC/HPLC/-MS, GC/IC/HPLC-ICP-MS.

BOOK SUGGESTED :

1. Instrumental methods of analysis, Willard, Meritt and Dean.
2. Basic concepts of analytical chemistry, S.M. Khopkar, John Wiley & Sons.
3. Metallurgical analysis, S.C. Jain.
4. Material Science and Engineering. An Introduction, W.D. Callister, Wiley.
5. Material Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
6. Fundamentals of Analytical Chemistry, Skoog, Welt, Holler and Crouch Thomson Learning Inc.

PAPER NO. CH - 20
MEDICINAL CHEMISTRY

Max. Marks : 80

UNIT – I DRUG DESIGN

A. Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship(SAR), factors affecting bioactivity, resonance, inductive effect. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship (QSAR).

B. Concepts of drug receptors, lipophilicity, pharmacophore, pharmacological activity and typical range of parameters related to drug likeness.

UNIT – II A. Pharmacokinetics:

Introductions to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process.

B. Pharmacodynamics:
Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, membrane active drugs, drug metabolism, significance of drug metabolism in medicinal chemistry.

UNIT – III **A.** Introduction of : Chemistry of cancer, tumor cell properties, oncongenes, cell life cycle, carcinogenesis and role of antioxidants.

B. Antineoplastic Agents :
Introduction, Alkylating agents, Antimetabolites, carcinolytic Antibiotics, mitotic inhibitors and plant products.

UNIT – IV **A. ANTIBIOTICS:**
Constitution and synthesis of Penicillins, chloramphenicol, tetracycline, streptomycin and cephalosporin.

B. ANTI MALARIALS :
Synthesis and properties of the following Antimalarial : 8-amino quinoline derivatives - Pamaquine, Primaquine, Pentaquine, Isopentaquine, 4-amino quinoline derivatives - , Santoquine, camaquine, Acridine derivatives - Mepacrine, Azacrin, Pyrimidine and Biguanid derivatives - Paludrine, Pyremethamine.

BOOK SUGGESTED:

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs.
2. D.V. Banthrope and J.B. Harbrone, Longman, Essex., Organic Chemistry, Vol. 2, I.L. Finar, ELBS.
3. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americans, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publish ers.
4. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers.
5. New Trends in Natural Product Chemistry, Att – ur – Rahman and M.I. Choudhary, Harwood, Academic Publishers.
6. Insectcides of Natural Origin, Sukh Dev, Harwood Academic Publishers.
7. Introduction to Medicinal Chemistry, A Gringuage, Wiley – VCH.
8. Wilson and Gisvold's Test Book of organic Medicinal and Pharmaceutical Chemistry, Robert F. Dorde.
9. Burger's Medicinal Chemistry and Drug Discovery, Vol – 1(Chapter – 9 and Ch-14), Ed. M.E. Wolff, John Wiley.
10. Goodman and Gilman's Pharmacological Basis of Therapeutics, Mc Graw – Hill.
11. The Organic chemistry of Drug Synthesis and Design Action, R.B. Silverman, Academic Press.
12. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.
13. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
14. Biochemistry, L. Stryer, W.H. Freeman.
15. Biochemistry, J. David Rawn, Neil Patterson.
16. Biochemistry, Voet and Voet, John Wiley.
17. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley

PAPER NO. CH - 21
MATERIAL AND NUCLEAR CHEMISTRY

Max.Marks : 80

UNIT- I **NON EQUILIBRIUM THERMODYNAMICS :** Fundamental concepts, Forces and Fluxes, Entropy production, Phenomenological Laws and Onsager's reciprocity relations, Irreversible thermodynamics for biological systems, coupled reactions.

UNIT- II **MATERIAL CHEMISTRY :**
Preparation and Properties of Nanopaeticles, Materials-Metals, Ceramics (Oxide, carbides, sulphides, nitrides).physical and chemical Methods, Size and Shape controlled Synthesis, Sol-gel methods, Optical Properteis, Electrical and Magnetic Properties, Application of Nanoparticles.

UNIT-III **SUPRAMOLECULAR CHEMISTRY :**
Properties of covalent bonds, bond length, inter bond angles, Force constant, bond and molecular dipole moment, molecular and bond polarizability.
Intermolecular Forces, hydrophobic effects, Electro static, induction, dispersion and resonance energy, Hydrogen bond, Magnetic interactions. Principles of molecular association ad organization Biological marcomolecules, Molecular receptors and design principal, cryptands, Cxclophanes, calixerancs and cyclodextrins.
Supramoleular reactivity and catalysis.

UNIT-IV **NUCLEAR AND RADIOCHEMISTRY**

NUCLEAR THEORY :
Nuclear cross section and nuclear radii, nuclear shells and magic numbers, theory of nuclear shell model, nuclear potentials, square well and simple harmonic oscillator potentials, application, liquid drop model, semi-empirical mass equation, application and limitations.

NUCLEAR FISSION :
Mass, energy and charge distribution of fission products, decay chains, prompt and neutrons, liquid drop model of nuclear fission.

NUCLEAR ENERGY :
Nuclear fission, chain reaction, multiplication factor, nuclear reactors

APPLIED RADIOCHEMISTRY :
Radioactive isotopes, purity and strength of radioisotopes. Radiochemical principle in the use of tracers, Application of Tracers in Chemical investigations, Physico-chemical methods, Analytical applications, Age determinations, Medical applications, Agricultural application.

BOOKS SUGGESTED:

1. Nuclear and Radiochemistry by G. Friedlander, J.W. Kennedy & J.M. Miller, John Wittey and Sons, Ine New York.
2. Source Book an Atomic Energy – S.Glasstone, Affiliated East – West Press Pvt. Ltd. New Delhi.
3. Nuclear Physics by I. Kaplan, Addision – Welsly. Publishing company London.
4. Nuclear Chemistry and its applications, M. Haissinsky, Addision – Welsley, Publishing Company, London.
5. Essentials of Nuclear chemistry, H.J. Arnikar, Wiley Eatern Ltd, New Delhi.
6. Molecular Mechanics, U. Burkert and N.L. Allinger, ACS Monograph 177, 1982.
7. Mechanism and Theory in Organic Chemistry, T.H. Lowry and K.C. Richrdson, Harper and Row.

8. Introduction to Theoretical Organic Chemistry and Molecular, Modelling, W.B. Smith, VCH, Weinheim.
9. Physical Organic Chemistry, N.S. Isaacs, ELBS./ Longman.
10. Supramolecular Chemistry: concept and Perspectives, J.M. Lehn, VCH.
11. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
12. Mathematics for Chemistry, Doggett and Sutclilffe, Longman.
13. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
14. Chemical Mathematics, D.M, Hirst, Longman.
15. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
16. Basic Mathematics for Chemists, Tebbutt, Wiley.
17. Quantum Chemistry, Ira N. Levine, Prentice Hall.
18. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.

PAPER NO. CH - 22
APPLIED CHEMICAL ANALYSIS

Max. Marks : 80

UNIT – I AIR POLLUTION MONITORING AND ANALYSIS

Classification of air pollution monitoring levels, air quality, standards and index, monitoring and analysis of selected air borne pollutants : SO_2, NO_x, SPM, VOC's, Pb, CO2, POP's, Hg, carbon and ozone air pollution control devices Viz ESP's, scrubber technique etc. Atmospheric chemistry of acid rains, photochemical smog, green house effect, global worming, ozone hole.

UNIT – II SOIL AND WATER POLLUTION

Soil and water quality standards, monitoring and analysis of selected soil water contaminates : COD, pesticides , heavy metals, POP's, fluoride, cynide, nitrate, phosphate, oil & greese, Geobiochemical impact of municipal solid waste, steel plants efficient, domestic sewage. Control devices of water pollutants.

UNIT – III FOOD ANALYSIS

A. Introduction to general Constituents of food, Proximate Constituents and their analysis, Additives- Introduction -Types - Study of preservatives colors and Antioxidants and method of estimation, adulteration - Introduction, Types, Test for adulterants.

B. Introduction standards composition and analysis of following foods : Wheat, Bread, Biscuits, Jam, Jelly, Honey, Milk, Ice Cream, Butter, Cheese, Milk Powder, Oils and Fats, Tea, Coffee, Soft drinks, Alcoholic beverages, Cercal and pulses, Confectionery, Fruits, Vegetables, Egg, Fish, Meat.

UNIT – IV COSMETICS, CLINICAL AND DRUG ANALYSIS

A. Introduction of Cosmetics, evaluation of cosmetics materials, raw material and additives, Cosmetics colors, Perfumes in cosmetics, Cosmetics formulating, introduction, standards and methods of analysis, Creams, face powders, Make-up, Shaving preparations, Bath preparations.

B. Concepts and principles of analytic methods commonly used in the clinical species: i.e. ammonia, blood urea Nitrogen, Ca, Cl, CO_2, Fe, K, Li, Mg, Na, P, urea, glucose.

Method for analysis of proteins (i.e. albumin, bilirubin, creatinine, cholesterol, HDL-cholesterol, triglycerides, creatinine) and Enzymes (i.e. Aanine Aminotransferase, acid phosphatase, alkaline phosphatase, amylase, aspartate aminotransferase, cholinesterase, lactate, and lipase).

BOOK SUGGESTED :

1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
2. Environmental chemistry, Sharma and Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern.
4. Environmental Chemistry, Analysis, S.M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Environmental Chemistry, C. Baird, W.H. Freeman.
8. Analytical chemistry, G.D. Christian, J. Wiley.
9. Fundamentals of Analytical Chemistry, D.A. Skoog, D.m. West and F.J. Holler, W.B. Saunders.
10. Analytical Chemistry - Principles, J.H. Kennedy, W.Saunders.
11. Analytical Chemistry-Principles, and Techniques, L.G. hargis, Prentice Hall.
12. Principles of Instrumental Analysis, D.a. Skoog and J.L. Loary, W.B. Saunders.
13. Principles of Instrumental Analysis, D.A. Skoog, W.B. Saunders.
14. Quantitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
15. Environmental Solution Analysis, S.M. Khopkar, Wiley Eastern.
16. Basic Concepts of Analytical Chemistry, S.M. Khopkar, Wiley Eastern.
17. Handbook of Instrumental Techniques for Analytical Chemistry, F. Settle, Prentice Hall.
18. Environmental Biotechnology, Indushekhar Thakur, I.K. International Pvt. Ltd.
19. Fundamental of Analytical Chemistry, D.A. Skoog, D.m. West, F.J. Holler and S.R. Crouch, Thompson Learning Inc.
20. APHA, 1977, "Methods of air Sampling and Analysis American Public Health Association Washington–US.

PAPER NO. CH – 23
LABORATORY COURSE – VII

Max. Marks 100

A. MULTI - STEP SYNTHESIS OF ORGANIC COMPOUNDS

(i) Beckmann Rearrangement: Benzanilide from benzene
(Benzene Benzophenone Benzophenone oxime Benzanilide).

(ii) Benzilic Acid Rearrangement: Benzilic acid from Benzoin (Benzoin Benzil Benzilic acid)

(iii) Skraup's synthesis (Synthesis of heterocyclic compounds)
Quinoline from o - Amino phenol

(iv) p - Bromoaniline from Aniline
(Aniline Acetanilide p - Bromoacetanilide p - Bromoaniline)

(v) p - Nitroacetanilide from Acetanilide
(Aniline Acetanilide p - Nitroactanilide p - Nitroaniline)

(vi) m - Nitroaniline from Benzene
(Benzene Nitrobenzene m - dinitrobenzene m - nitroaniline)

(vii) Acridone from Anthranilic acid
(Anthranilic acid o - Chlorobenzoic acid N - Phenylanthranilic acid Acridone)

(viii) Enzymatic Synthesis
Enzymatic reduction : Reduction of ethylacetoacetate using Baker's yeast to yield enantiomeric
excess of S(+) ethyl - 3 - hydroxybutanone and determine its optical purity.

B. QUANTITATIVE ORGANIC ANALYSIS

(i) Estimation of Sulphur by Messenger's Method.

(ii) Estimation of Nitrogen by Kjeldahl Method.

C. ESTIMATION OF FUNCTIONAL GROUP

(i) Extimation of Aniline.
(ii) Estimation of Amino Group By Acetylation Method.
(iii) Estimation of Hydroxyl Group By Acetylation Method.
(iv) Estimation of Carbonyl Group By Hydrazone Formation Method.
(v) Estimation of Carboxyl Group By Titration Method.
(vi) Determination of Equivalent Weight of Carboxylic Acid By Silver Salt Method.
(vii) Estimation of Glucose By Fehling Solution Method.
(viii) Estimation of Glycine By Titraiton Method.

D. EXTRACTION OF ORGANIC COMPOUNDS FROM NATURAL SOURCES

(i) Isolation of caffeine from leaves.
(ii) Isolation of Casein from milk.
(iii) Isolation of lactose from milk.
(iv) Isolation of nicotine dipicrate from tabacco.
(v) Isolation of Cinchonine from cinchona bark.
(vi) Isolation of Piperine from black pepper.
(vii) Isolation Lycopene from tomatoes.
(viii) Isolation of β – Carotene from carrots.
(ix) Isolation of Limonene from citrus rinds.
(x) Isolation of protein and carbohydrates from seeds – colour test
(xi) Extraction of Fatty oil from seeds and determination of refractive index of the oil.
(xii) Isolation of protein and carbohydrate (as reducing sugars) from seed-colour test.

BOOKS SUGGESTED :

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.
3. Practical Organic chemistry by Garg and Saluja.
4. The Systematic Identification of Organic compounds, R. L. Shriner and D. Y. Curtin.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J. B. Entrikin and E. M. Hodnett.
6. Experimental Organic chemistry, M. P. Doyle and W. S. Mungall.
7. Small Scale Organic preparation, P. J. Hill.
8. Experimental Biochemistry, by B.S.Roa and V.Deshpande. I.K. International Pvt.Ltd.
9. Comprehensive Practical Organic Chemistry, Preparation and Qualitative Analysis, V.K.Ahluwalia and Renu Aggarwal, University Press.

PAPER NO. CH – 24
LABORATORY COURSE - VIII

Max. Marks 100

A. TITRIMETIC/GRAVIMETRIC DETERMINATIONS

(i) Manganese in iron / Steel by Bismuthate / Linganane – Karplus/Periodate methods.
(ii) Maganese in pyrolusite ores.
(iii) Nickel in steel by dimethylglyoxine method.
(iv) Lead by dithizone precipitation.

B. SPECTROPHOTOMETRIC DETERMINATIONS

(i) Maganese/Chromium / Vanadium / Copper / Lead in Steel and Environmental / Industrial effluent samples.
(ii) Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive spectrophotometric methd.

(iii) Fluoride / Nitrite / Phosphate in tap / pond / river industrial waste water.
(iv) Iron in water samples by thiocyanate and phenanthroline methods.

C. CHROMATOGRAPHIC SEPARATION

1. Sepraration and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.
2. Thin layer chromatography – separation of nickel, manganese, cobalt and zinc. Determination of Rf values.

D. FLOW INJECTION ANALYSIS.

Determination of the following anions/cations in synthetic/real/ environmental samples.
(i) Ca^{2+}, Mg^{2+}, Al^{3+}, Mn^{2+}, Cr^{3+}, Fe^{3+}
(ii) F^-, Cl^-, PO_4^{3-}, NO_2^-, NO_3^-, SO_4^{2-}, BO_3^{3-}.

E. ATOMIC ABSORPTION SPECTROPHOTOMETER

Determination of metal contents (Fe/Pb/As/Zn/Co/Ni etc.) in real and environmental samples.

F. MISCELLANEOUS

(i) Nutrient and micronutrient analysis in plant/soil/sediment.
(ii) Speciation of toxic metals i.e. As, Hg, Se, etc.
(iii) Analysis of clinical samples i.e. blood, urine, hair, etc.

BOOK SUGGESTED :

1. Quantitative Inorganic Analysis, A.I. Vogel.
2. Standard Methods of Water Analysis.
3. Colorimetric Determination of Traces of Metals, E.B. Sandell.
4. GBC, Manuals on AAS analysis, Austria.
