

**Department of Chemistry**  
**Govt. D.B. Girls' P.G. Autonomous**  
**College, Raipur (C.G.)**



**SYLLABUS**  
**2017-18**

**M.Sc. (Chemistry)**  
**Semester Examination**



# **EXAMINATION SCHEME**

M.Sc. examination will be conducted in four SEMESTERS. Each semester exam shall consist of FOUR THEORY papers and TWO PRACTICALS.

## **SEMESTER – I**

### **Theory**

| PAPER     | TITLE   | MARKS  |      |      |      |         |      | TOTAL | Credit Points |
|-----------|---|--------|------|------|------|---------|------|-------|---------------|
|           |   | THEORY |      | TEST |      | SEMINAR |      |       |               |
|           |   | Max.   | Min. | Max. | Min. | Max.    | Min. |       |               |
| Paper-I   | GROUP THEORY AND CHEMISTRY OF METAL COMPLEXES               | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-II  | CONCEPTS IN ORGANIC CHEMISTRY                               | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-III | QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - I | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-IV  | THEORY AND APPLICATIONS OF SPECTROSCOPY- I                  | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |

### **Practical**

|              | Practical           | MARKS |      | Credit Points |
|--------------|---------------------|-------|------|---------------|
|              |                     | Max.  | Min. | Max.          |
| Practical I  | INORGANIC PRACTICAL | 100   | 36   | 02            |
| Practical II | PHYSICAL PRACTICAL  | 100   | 36   | 02            |

**Total Marks for First Semester - 600**

## SEMESTER – II

### Theory

| PAPER     | TITLE  | MARKS  |      |      |      |         |      | TOTAL | Credit Points |
|-----------|--|--------|------|------|------|---------|------|-------|---------------|
|           |  | THEORY |      | TEST |      | SEMINAR |      |       |               |
|           |  | Max.   | Min. | Max. | Min. | Max.    | Min. |       |               |
| Paper-I   | TRANSITION METAL COMPLEXES                                   | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-II  | REACTION MECHANISMS  | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-III | QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - II | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-IV  | THEORY AND APPLICATIONS OF SPECTROSCOPY –II                  | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |

### Practical

|              | Practical            | MARKS |      | Credit Points |
|--------------|----------------------|-------|------|---------------|
|              |                      | Max.  | Min. | Max.          |
| Practical I  | ORGANIC PRACTICAL    | 100   | 36   | 02            |
| Practical II | ANALYTICAL PRACTICAL | 100   | 36   | 02            |

**Total Marks for First Semester - 600**

## SEMESTER – III

### Theory

| PAPER     | TITLE   | MARKS  |      |      |      |         |      | TOTAL | Credit Points |
|-----------|---|--------|------|------|------|---------|------|-------|---------------|
|           |   | THEORY |      | TEST |      | SEMINAR |      |       |               |
|           |   | Max.   | Min. | Max. | Min. | Max.    | Min. |       |               |
| Paper-I   | RESONANCE SPECTROSCOPY & PHOTOCHEMISTRY                               | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-II  | CHEMISTRY OF BIO-MOLECULES  | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-III | STATISTICAL THERMODYNAMICS, SOLID STATE POLYMER AND SURFACE CHEMISTRY | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-IV  | ANALYTICAL TECHNIQUES AND DATA ANALYSIS                               | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |

### Practical

|              | Practical            | MARKS |      | Credit Points |
|--------------|----------------------|-------|------|---------------|
|              |                      | Max.  | Min. | Max.          |
| Practical I  | PHYSICAL PRACTICAL   | 100   | 36   | 02            |
| Practical II | ANALYTICAL PRACTICAL | 100   | 36   | 02            |

**Total Marks for First Semester – 600**

## SEMESTER – IV

### Theory

| PAPER     | TITLE                                     | MARKS  |      |      |      |         |      | TOTAL | Credit Points |
|-----------|---|--------|------|------|------|---------|------|-------|---------------|
|           |   | THEORY |      | TEST |      | SEMINAR |      |       |               |
|           |   | Max.   | Min. | Max. | Min. | Max.    | Min. |       |               |
| Paper-I   | NATURAL PRODUCTS AND MEDICINAL CHEMISTRY  | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-II  | CATALYSIS, MATERIAL AND NUCLEAR CHEMISTRY | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-III | INSTRUMENTAL METHODS OF ANALYSIS          | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |
| Paper-IV  | ENVIRONMENTAL & APPLIED CHEMICAL ANALYSIS | 80     | 16   | 10   | 02   | 10      | 02   | 100   | 04            |

### Practical

|              | Practical            | MARKS |      | Credit Points |
|--------------|----------------------|-------|------|---------------|
|              |                      | Max.  | Min. | Max.          |
| Practical I  | ORGANIC PRACTICAL    | 100   | 36   | 02            |
| Practical II | ANALYTICAL PRACTICAL | 100   | 36   | 02            |

**Total Marks for First Semester - 600**

# FIRST SEMESTER

## PAPER NO. - I

### GROUP THEORY AND CHEMISTRY OF METAL COMPLEXES

**MAXIMUM MARKS: 80**

**NUMBER OF UNITS : IV**

#### 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. Schoenflies 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 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, di-nitrogen and di-oxygen complexes; tertiary phosphine as ligand.

#### UNIT III

- A. **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.
- B. **ISOPOLY ACID AND HETEROPOLY ACID:** 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, properties and application.

#### UNIT IV

- A. **METAL CLUSTERS:** Higher boranes, carboranes, metalloboranes and metallocarboranes, metal carbonyl and halide cluster, compounds with metal-metal multiple bonds.
- B. **CHAINS:** Catenation, Heterocatenation, Interactenation.
- 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. Earnshaw, Pergamon.
4. Comprehensive Coordination Chemistry Eds. G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.

# FIRST SEMESTER

## PAPER NO. - II

### CONCEPTS IN ORGANIC CHEMISTRY

**MAXIMUM MARKS:80**

**NUMBER OF UNITS : IV**

#### UNIT I

- A. **NATURE OF BONDING IN ORGANIC MOLECULES:** Localized and delocalized chemical bonding, conjugation, resonance, hyperconjugation, cross-conjugation, bonding in fullerenes. Bonds weaker than covalent, alternant and non-alternant hydrocarbons, Crown ether complexes and cryptands.
- B. **AROMATICITY:** Aromaticity in benzenoid 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<sub>2</sub>, E<sub>1</sub> and E<sub>1cB</sub> mechanism. 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 – antarafacial and suprafacial additions, 4n and 4n+2 system, 2+2 addition of ketenes, 1, 3 dipolar cycloadditions and cheletropic reactions. Sigmatropic rearrangements – suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3, 3- and 5, 5- sigmatropic rearrangements. Claisen, Cope and Aza-Cope rearrangements. Ene reaction.

#### BOOK SUGGESTED:

1. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, plenum.
2. A Guidebook 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, Blackie Academic and Professional.
7. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
9. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
10. Some Modern Methods of organic Synthesis, W. Carruthers, Cambridge University 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.

**FIRST SEMESTER  
PAPER NO.- III**

**QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - I**

**MAXIMUM MARKS: 80**

**NUMBER OF UNITS: IV**

**UNIT I**

- A. **MATHEMATICAL CONCEPT IN QUANTUM CHEMISTRY:** Vector, Dot Cross and triple products. Complex numbers and co-ordinate transformations (Cartesian to Spherical Polar in Quantum Chemistry). Differential and Integral Calculus, Basis rules of differentiation and Integration Applications.
- B. **QUANTUM MECHANICS:** The Schrodinger equation and the 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 rotor, the hydrogen atom.

**UNIT II**

**BASICS OF THERMODYNAMICS:** Maxwell's thermodynamic relations and its applications. Reaction isotherm, Vant 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.

**UNIT III**

**ELECTROCHEMISTRY - I:** Electrochemistry of solution, Debye-Huckel Onsager treatment and its extension, ion solvent interactions. Debye-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 electrocapillarity, 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-Zabolonsky reaction).

**BOOK SUGGESTED:**

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sutcliff, Longman.
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
4. Applied Mathematics for Physical Chemistry, J.r. Barrante, Prentice Hall.
5. Basic Mathematics for Chemists, Tebbutt, Wiley.
6. Physical Chemistry, P.W. Atkins, ELBS.
7. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
8. Quantum Chemistry, Ira Nl. Levine, Prentice Hall.
9. Coulson's Valence, R. McWeeny, ELBS.
10. Chemical Kinetics, K.J. Laidler, Pearson.
11. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose.
12. Modern Electrochemistry Vol. I & II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
13. Thermodynamics for chemists, S. Glasstone EWP.
14. An Introduction to Electrochemistry S. Glasstone, EWP.
15. Physical Chemistry, Ira N. Levine McGraw Hill.



# FIRST SEMESTER

## PAPER NO. - IV

### THEORY AND APPLICATIONS OF SPECTROSCOPY- I

**MAXIMUM MARKS: 80**

**NUMBER OF UNITS: IV**

#### UNIT I

**UNIFYING PRINCIPLES:** Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, transition moment, selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels. Regions of spectrum, representation of spectra, F.T. spectroscopy, computer averaging, lasers.

#### UNIT II

- A. **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. Application in determination of bond length.

#### UNIT III

##### **SCATTERING SPECTROSCOPY:**

Principle, instrumentations and application of Auger spectroscopy and Scanning Electron Microscopy for chemical characterization, electron diffraction of gases and vapours, The Wierl equation and co-related method, application of electron diffraction.

Theory, instrumentation and application of turbidimetry, nephelometry and fluorometry. Fluorescence and phosphorescence and factors affecting them.

#### UNIT IV

##### A. **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  $\text{CO}_2$ ,  $\text{N}_2\text{O}$ ,  $\text{SO}_2$ ,  $\text{NO}_3^-$ ,  $\text{ClF}_3$

##### B. **MOSSBAUER SPECTROSCOPY:**

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of  $\text{Fe}^{+2}$ , and  $\text{Fe}^{+3}$  compounds including those of intermediate spin, (2),  $\text{Sn}^{+2}$  and  $\text{Sn}^{+4}$  compounds.

#### **BOOK SUGGESTED:**

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L. Ho, Wiley.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
6. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. orchin, IBH-Oxford.
7. C.N. Banwell, "Fundamental of Molecular Spectroscopy", Mc.Graw Hill.
8. Introduction to Magnetic Resonance, A Carrington and A.D. Maclachalan, Harper & Row.

**FIRST SEMESTER  
PRACTICAL NO. - I  
INORGANIC PRACTICAL**

**MAXIMUM MARKS:100**

**A 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, Fluoride, Chloride, Bromide, Iodide, Sulphate, Borate, Oxalate, Phosphate, Silicate, Thiosulphate, Ferrocyanide, Ferricyanide, Sulphocyanide, Chromate, Arsenate and Permanganate.

**B 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.

**C ESTIMATION OF:**

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

**D PREPARATIONS:**

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

- |  |  |
|--|--|
| 1. VO (acac) <sub>2</sub>  | 2. TiO (C <sub>9</sub> H <sub>9</sub> NO) <sub>2</sub> 2H <sub>2</sub> O       |
| 3. cis-K [C <sub>9</sub> H <sub>8</sub> NO] <sub>2</sub> . (H <sub>2</sub> O) <sub>2</sub> | 4. Na [Cr (NH <sub>3</sub> ) <sub>2</sub> (SCN) <sub>4</sub> ]                 |
| 5. Mn (acac) <sub>3</sub>  | 6. K <sub>2</sub> [Fe(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> ]           |
| 7. Prussian Blue, Turnbull's Blue  | 8. [Co (NH <sub>3</sub> ) <sub>6</sub> ] [Co (NO <sub>2</sub> ) <sub>6</sub> ] |
| 9. cis-[Co (trien) (NO <sub>2</sub> ) <sub>2</sub> ] Cl. H <sub>2</sub> O                  | 10. Hg [Co (SCN) <sub>4</sub> ]  |
| 11. [Co (Py) <sub>2</sub> Cl <sub>2</sub> ]  | 12. [Ni (NH <sub>3</sub> ) <sub>6</sub> ] Cl <sub>2</sub>                      |
| 13. Ni (dmg) <sub>2</sub>  | 14. [Cu (NH <sub>3</sub> ) <sub>4</sub> ] SO <sub>4</sub> , H <sub>2</sub> O   |

**BOOK 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.

**FIRST SEMESTER  
PRACTICAL NO.- II  
PHYSICAL PRACTICAL**

**MAXIMUM MARKS: 100**

**A 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.  
Determination of CMC of surfactants.

**B PHASE EQUILIBRIA:**

To construct the phase diagram for three component system (e.g., chloroform-acetic acid-water)

**C 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 reaction.
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  $\text{Fe}^{+++}$
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)

**D 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 measurement.

**E 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.,  $\text{PbSO}_4$ ,  $\text{BaSO}_4$ ) conductometrically.
3. Determination of  $\text{pK}_a$  of Acetic acid and verification of Ostwald dilution law.

**F POTENTIOMETRY/pH METRY**

1. Determination of the strength and weak acids in a given mixture using a potentiometer/pH meter.
2. Determination of the dissociation constant 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  $\text{Fe}^{++}/\text{Fe}^{+++}$  system.

**G 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.

**BOOK 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. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

## SECOND SEMESTER

### PAPER NO.- I

#### TRANSITION METAL COMPLEXES

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

#### 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, 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 ( $d^1$ - $d^9$  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  $[M(H_2O)]^{n+}$  spin free and spin paired  $ML_6$  complexes of other geometries, Calculations of  $Dq$ ,  $B$  and parameters, spin forbidden transitions, effect of spin-orbit coupling, Spectrochemical and Nephelouxic series. Magnetic properties of complexes of various geometries based on crystal field model, spin free-spin paired equilibria in octahedral stereochemistry.

#### UNIT III

- A. **TRANSITION METAL COMPLEXES:** Transition metal complexes with unsaturated organic molecules, alkanes, allyl, diene dienyl, arene and trienyl complex, preparations, properties, nature of bonding and structure features, important reaction relating to nucleophilic and electrophilic attack on ligands and organic synthesis.
- B. **TRANSITION METALS COMPOUND WITH BOND TO HYDROGEN:** Transition Metals Compounds 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.

#### BOOK SUGGESTED:

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

## SECOND SEMESTER

### PAPER NO. - II

#### REACTION MECHANISMS

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

#### UNIT I

**A. ALIPHATIC NUCLEOPHILIC SUBSTITUTION:**

The  $S_N^2$ ,  $S_N^1$  mechanisms. The neighbouring group mechanism, neighbouring group participation by  $\pi$  bond, 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  $S_NAr$ ,  $S_N^1$  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, ipso attack, orientation in other ring systems. Vilsmeier 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, Michael reaction, Sharpless asymmetric epoxidation.

#### UNIT IV

**ADDITION TO CARBON-HETERO MULTIPLE BONDS:**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters, nitriles. Addition of Grignard Reagent, Organo-Zn, 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.

#### BOOK SUGGESTED:

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

## SECOND SEMESTER

### PAPER NO.- III

#### QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS - II

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

#### UNIT I

**A. APPLICATION OF MATRICES IN QUANTUM CHEMISTRY:**

Addition and multiplication, inverse and transpose of matrices. Determinants, in quantum chemistry.

**B. ANGULAR MOMENTUM IN QUANTUM CHEMISTRY:** Angular Momentum, Ordinary Angular Momentum, Generalized Angular Momentum, Eigen-functions for Angular Momentum, Eigen values of Angular Momentum, Operators.

**C. APPROXIMATE METHOD:**

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

#### UNIT II

**A. THERMODYNAMICS OF NON IDEAL GASES:**

Activity and Fugacity, Determination of Fugacity, Variation of Fugacity with Temperature and Pressure.

**B. NON EQUILIBRIUM THERMODYNAMICS:**

Fundamental concepts, forces and fluxes, Entropy production, Phenomenological Laws and Onsager's reciprocity relations.

#### UNIT 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.

#### UNIT 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.

#### BOOK SUGGESTED:

1. The Chemistry Mathematics Book, E.Steiner, Oxford University Press.
2. Mathematics for Chemistry, Deoggett and Sutcliffe, Longmann.
3. Mathematics preparation for Physical Chemistry, F. Daniels, McGraw Hill.
4. Chemical Mathematics, D.M. Hirst, Longmann.
5. Physical Chemistry, P.W. Atkins, ELBS.
6. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
7. Quantum Chemistry, Ira N.Levine, Prentice Hall.
8. Chemical Kinetics, K.J. Laidler, Pearson.
9. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
10. Modern Electrochemistry Vol. I & II, J.O.M. Bockris and A.K.N. Reddy, plenum.
11. Thermodynamics for Chemists, S.Glastone EWP.
12. An Introduction to Electrochemistry S. Glasstone EWP.
13. Physical Chemistry, Ira, N. Levine McGraw Hill.

## SECOND SEMESTER

### PAPER NO. - IV

#### THEORY AND APPLICATIONS OF SPECTROSCOPY –II

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

#### UNIT I

##### **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, dyes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls. intensity of vibrational-electronic spectra and Frank-Condon principle for dissociation energy, rotational fine structure of electronic-vibrational spectra, Shape of some molecular orbitals viz.,  $H_2$ ,  $He_2$ ,  $N_2$ ,  $O_2$ . 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. Instrumentation.

#### UNIT II

##### **A. INFRARED SPECTROSCOPY:**

Introduction, simple and anharmonic oscillators in vibrational spectroscopy, diatomic-vibrating rotator, Modes of vibration in polyatomic molecules, vibration-coupling, Fourier Transform IR spectroscopy: instrumentation, interferometric spectrophotometer, sample handling, Factors influencing vibrational frequencies, Application of IR spectroscopy: Interpretation of IR spectra of normal alkanes, aromatic hydrocarbons, alcohols and phenols aldehydes and ketones, ethers, esters, carboxylic acids and amines and amides.

##### **B. FOURIER TRANSFORM INFRARED SPECTROSCOPY:**

Introduction, instrumentation, Michelson interferometer, slow scan, stepped scan and rapid scan interferometers, sources and detectors, resolution and wave number measurements, sources of error, computation and recording advantages.

#### 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, Alkenes, Aromatic hydrocarbons, Alcohols, Amines. Nitrogen rule, ring rule, Molecular weight and formula determination, Gas chromatography-Mass spectrophotometry: Introduction.

#### UNIT IV

##### **A. NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY:**

Chemical shift values & correlation for protons bonded to carbon (aliphatic, olefinic & aromatic) & other nuclei (Alcohols, Phenol ends Carbonylic acids amines, amides and marcapto) chemical exchange effect of deuteration. Nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform techniques.

##### **B. CARBON – $^{13}$ NMR SPECTROSCOPY:**

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

#### **BOOK SUGGESTED:**

1. Microcomputational Quantum Mechanics, J.P. Killngbeck, Adam Hilger.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi, and F.L.Ho, Wiley.
4. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
5. W. Kemp, "Organic Spectroscopy" Longmann.

**SECOND SEMESTER  
PRACTICAL NO.- I  
ORGANIC PRACTICAL**

**MAXIMUM MARKS :100**

**A GENERAL METHODS OF SEPARATION AND PURIFICATION OF ORGANIC COMPOUNDS WITH SPECIAL REFERENCE TO:**

1. Solvent Extraction.
2. Fractional Crystallization.

**B DISTILLATION TECHNIQUES:**

Simple distillation, steam distillation, Fractional distillation and distillation under reduced pressure.

**C 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).

**D PREPARATION OF ORGANIC COMPOUNDS: SINGLE STAGE PREPARATIONS:**

1. **Acetylation:** Synthesis of  $\beta$ -Naphthyl from  $\beta$ -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:**  $\beta$ -Naphthyl benzoate from:  $\beta$ -Naphthol/Phenyl benzoate from phenol.
11. **Sulphonation Reaction:** Sulphanilic acid from aniline.

**BOOK SUGGESTED:**

1. Practical Organic Chemistry, by A.I. Vogel/Mann and Saunders/Garg and Saluja.
2. The Systematic Identification of Organic Compounds, R.L. Shriner & D.Y. Curtin.
3. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett.
4. Practical Physical Chemistry by Alexander Findlay.
5. Experimental Physical Chemistry, D.P. Shoemaker, G.W. Garland and J.W. Niber, McGraw Hill Interscience.
6. Findlay's Practical Physical Chemistry revised B.P. Levitt, Longmann.



## SECOND SEMESTER PRACTICAL NO.- II

### ANALYTICAL PRACTICAL

**MAXIMUM MARKS :100**

#### **I ERROR ANALYSIS AND STATISTICAL DATA ANALYSIS:**

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 EXCEL, WORD, 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 Vitamins.

#### **V SPECTROSCOPY:**

1. Verification of Beer's Lambert Law.
2. Determination of stoichiometry and stability constant of inorganic (e.g. ferric-salicylic acid) and organic (e.g. amine-iodine) complexes, thiocyanam.
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, prentice Hall.
6. Experiments in Chemistry, D.V. Jahagirgar.

## THIRD SEMESTER

### PAPER NO.- I

#### RESONANCE SPECTROSCOPY & PHOTOCHEMISTRY

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

#### UNIT I

- A. **ELECTRON SPIN RESONANCE SPECTROSCOPY:** Hyperfine coupling, polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron)
- B. **NUCLEAR QUADRUPOLE RESONANCE SPECTROSCOPY:** Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splittings, applications.

#### UNIT II

- A. **PHOTOELECTRON SPECTROSCOPY:** Basic principle both for atoms and molecules; Photo-electric effect, ionization process, Koopman's theorem, photoelectron spectra of simple molecules, Debye and Clausius-Mossotti equation, Auger electron spectroscopy, Determination of Dipole moment.
- B. **PHOTOACOUSTIC SPECTROSCOPY:** Basic Principle of Photo acoustic Spectroscopy (PAS), PAS – gases and condensed system Chemical and Surface application.

#### UNIT III

- A. **PHOTOCHEMICAL REACTION:** Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, Actinometry.
- B. **DETERMINATION OF REACTION 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.
- C. **MISCELLANEOUS PHOTOCHEMICAL REACTIONS:** Photo-Fries reactions of anilides, Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers, Photochemistry of vision.

#### UNIT IV

- A. **PHOTOCHEMISTRY OF ALKENES:** Intramolecular reaction of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1, 4 & 1, 5 dienes.
- B. **PHOTOCHEMISTRY OF CARBONYL COMPOUNDS:** Intramolecular reactions of carbonyl compounds, Cyclohexadienones. Intermolecular Cycloaddition reactions – dimerisations and oxetane formation.
- C. **PHOTOCHEMISTRY OF AROMATIC COMPOUNDS:** Isomerisations, additions and substitutions.

#### BOOK SUGGESTED:

1. Infrared & Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
2. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
3. Essential of Molecular Photochemistry, A. Gilbert & J. Baggott, Blackwell Scientific Publications.
4. Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
5. Introductory Photochemistry, 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.

**THIRD SEMESTER**  
**PAPER NO.- II**  
**CHEMISTRY OF BIO-MOLECULES**

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

**UNIT I**

- A. **BIOENERGETICS:** Standard free energy changes 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 iron-sulphur proteins, synthetic models.
- C. **TRANSPORT & 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 – carboxypeptidase and carbonic anhydrase. Iron enzymes – catalase, peroxidase and cytochrome P-450. Copper enzymes – superoxide dismutase. Molybdenum oxotransferase 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 of 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<sup>+</sup>, NADP<sup>+</sup>, FMN, FAD, lipoic acid, vitamin B<sub>12</sub>.
- C. **BIOTECHNOLOGICAL APPLICATION OF ENZYMES:** Techniques 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 mechanochemical 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 & 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, Elsevier.
4. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C.Penny, Springer-verlag.
5. Understanding Enzymes, Trevor Plamer, Prentice Hall.
6. Enzymes Chemistry: Impact and Application, Ed. Collin J. Suckling, Chapman and Hall.

**THIRD SEMESTER**  
**PAPER NO.- III**  
**STATISTICAL THERMODYNAMICS, SOLID, POLYMER, AND SURFACE**  
**CHEMISTRY**

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

**UNIT I**

**STATISTICAL THERMODYNAMICS:**

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.

**UNIT II**

**POLYMER CHEMISTRY:**

- A. Importance of basics polymers, Basic concept monomers, Degree of polymerization linear branched and network polymers, classification of polymers polymerization, Condensation, addition, radical chain-ionic and co-ordination & copolymerization polymerization conditions and polymer reactions polymerization in homogenous and heterogenous system.
- B. Polymer structure and physical properties-crystalline melting point,  $T_m$ -melting points of homogenous series. The glass transition temperature  $T_g$  relationship between  $T_m$  &  $T_g$  effect of molecular weight, diluents, branching & cross linking property requirements and polymer utilization.

**UNIT III**

**A. SOLID STATE CHEMISTRY**

Crystal defects and Non-stoichiometry-Perfect and imperfect crystals, intrinsic and extrinsic defects – point defect, line and plane defects, vacancies – Schottky defects and Frankel defects. Thermodynamics of Schottky and Frenkel defect, formation of color centers, non-stoichiometry and defects.

**B. ELECTRONIC PROPERTIES & BAND THEORY:**

Metal insulators and semiconductors, electronic structure of solids band theory, band structure metals, insulators and semiconductors intrinsic and extrinsic semiconductors, doping semiconductors P-n junction, super conductors.

**UNIT IV**

**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), adsorption isotherm.

**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. M.C. Gupta, "Elements of Statistical Thermodynamics". New Age International (P) Ltd.
5. L.K. Nash, "Elements of Statistical Thermodynamics". Addison Wesley Publishing Co.
6. Kestin and Fofman. "Statistical Thermodynamics".
7. J. Rose, "Dynamic Physical Chemistry "Sir Issac Pitman & Sons.
8. Solid State Chemistry and its Applications A.R. West, Plenum.
9. Principle of Solid State H.V. Kar, Wiley Eastern.
10. Solid State Chemists, D.K. Chakrabarty, New Age International Pvt. Ltd.
11. Polymer Science, V.R. Gowariker, N.V. Vishwanathan.
12. Textbook of Polymer Science, F.W. Billmeyer Jr. Wiley.

**THIRD SEMESTER**  
**PAPER NO.- IV**  
**ANALYTICAL TECHNIQUES AND DATA ANALYSIS**

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

**UNIT I**

**SAMPLE PREPARATION, DIGESTION 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 acid 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, Propagation of errors, Normal Distribution Curve, Standard deviation, Confidence limit, Graphical presentation of result-method of average, Method of Linear least 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 of Extraction, applications.
- B. Principle, classification of chromatographic techniques, Technique and applications of paper chromatographic, Thin-layer chromatographic, HPTLC, Column chromatography.

**UNIT III**

**THERMAL AND AUTOMATED METHODS**

- A. Principle, Instrumentation, Application of TGA, DTA and DSC methods.
- B. Automated methods, Principle, instrumentation and application of flow injection analysis.

**UNIT IV**

**ELECTRO ANALYTICAL TECHNIQUES**

- A. Principles and instrumentation of pH potentiometry, coulometry and conductometry.
- B. Basic principles, Diffusion current, polarized electrode, Micro electrode, Dropping Mercury Electrode Ilkovic equation, Polarographic wave, Qualitative analysis 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. Saunders, College Publication.
2. Textbook of Quantitative Inorganic Analysis-Vogel A.I.
3. Principles and Practice of Analytical Chemistry-Fifield F.W and Kealey, D. Black well Science
4. Instrumental Analysis R. Braun, McGraw Hill, International Edition.
5. Analytical Chemistry, Christian, G.D., WSE/Wiley.
6. Instrumental Analysis, Willard Meritt Dean, CBS.
7. Chemical Analysis, Brawn, McGraw Hill.
8. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M.
9. Principles of instrumental analysis, Skoog Holler - Niemann.
10. Instrumental analysis, Wizard Dean and Merit.
11. Principle and PRACTICAL analytical chemistry, Fifield and Kealey.

**THIRD SEMESTER  
PRACTICAL NO.- I  
PHYSICAL PRACTICAL**

**MAXIMUM 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  $\alpha$  radiation.
5. Determination of absorption coefficient & half thickness of lead for gamma radiation.
6. Determination of range and energy of  $\alpha$  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  
(a) Volumetric Method (b) Conductometric Method
16. Saponification of ethyl acetate  
(a) Volumetric Method (b) Conductometric Method
17. Reaction between Acetone and Iodine.
18. To study the autocatalytic reaction between  $\text{KMnO}_4$  and Oxalic acid.
19. Reaction between  $\text{K}_2\text{S}_2\text{O}_8$  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 substrate catalyst etc (i) HCL,  $\text{K}_2\text{S}_2\text{O}_8$  (ii) KOH, NaOH
25. To study the Activation parameters.
26. To study the solvent effect using some Aprotic & Protic Solvents.
27. To examine the substitute 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.
31. To determine solubility product of  $\text{BaSO}_4$  or  $\text{AgCl}$  by conductometric method.
32. To determine dissociation constant of Acetic Acid by conductometric method.
33. To determine basicity of Oxalic Acid by conductometric method.

**BOOK SUGGESTED:**

1. Basic Experiment with radioisotopes by John, N. Andrews & David J. Hornsey, Pitman 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 practical Physical Chemistry, revised B.P. Levitt, Longman.

**THIRD SEMESTER  
PRACTICAL NO.- II  
ANALYTICAL PRACTICAL**

**MAXIMUM MARKS :100**

**A SPECTROPHOTOMETRIC DETERMINATIONS:**

1. Manganese / Chromium, Vanadium in steel sample.
2. Nickel / Molybdenum / Tungsten / Vanadium / Uranium by extractive spectrophotometric method.
3. Fluoride / Nitrate / Phosphate.
4. Iron – phenanthroline complex; Job's Methods of continuous variations.
5. Zirconium – Alizarin Red – S Complex: Mole-ratio method.
6. Copper – Ethylene diamine complex: Slope-ratio method.
7. Test the validity of Beer Lambert law using a Dubosqu colorimeter.

**B pH METRY:**

1. Stepwise proton-ligand and metal-ligand stability constant of complexes by Leving-Rossoti methods.
2. Determine the pH of a buffer solution using a aminhydrene electrode.
3. Determine the pH of various mixture of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of the acid.

**C CONDUCTOMETRY:**

1. Determine the end point of titration between HCl and NaOH by conductometric method.
2. Determine the end point of titration between Acetic acid and NaOH by conductometric method.
3. Determine the end point of titration between HCl, Acetic and and NaOH by conductometric method.

**D POLAROGRAPHY:**

Composition and stability constant of complexes.

**E FLAME PHOTOMETRIC DETERMINATIONS:**

- (a) Sodium and Potassium when present together.
- (b) Lithium / Calcium / Barium / Strontium
- (c) Cadmium and Magnesium in tap water

**F 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)

**G SEPARATION & 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. Textbook 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. – I

#### NATURAL PRODUCTS AND MEDICINAL CHEMISTRY

**MAXIMUM MARKS: 80**

**NUMBER OF UNITS : IV**

#### UNIT I

- A. **TERPENOIDS AND CAROTENOIDS:** Occurrence, isolation classification, nomenclature, general methods of structure determination of and synthesis Citral, Geraniol, Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and Carotene.
- B. **ALKALOIDS:** Occurrence, isolation nomenclature and physiological action stereochemistry of steroids general methods of structure elucidation, degradation, classification, synthesis of the following alkaloids: Ephedrine, (++ Conline, Nicotine, Atropine, Quinine and Morphine.

#### UNIT II

- A. **STEROIDS:** Introduction, structural features, structure determination, stereochemistry and synthesis of Cholesterol, Biosynthesis of cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone.
- B. **PLANT PIGMENTS:** Occurrence, nomenclature and general method of structure determination. Synthesis of Quercetin, Myrcetin, Diadazine, Cyanidin, Hisutinidin.

#### UNIT III

- A. **DRUG DESIGN:** Development of new drugs, procedures followed in drug design, concept of lead compound and lead modifications, concept of prodrug and soft drug, structure activity relationship (SAR), factors affecting bioactivity, resonance, inductive effect. Theories of Drug Activity – Occupancy theory, rate theory and induced fit theory.
- B. **PHARMACOKINETICS AND PHARMACODYNAMICS:** Definition and general introduction.

#### UNIT IV

- A. **ANTIBIOTICS:** Constitution and synthesis of Penicillins, chloramphenicol, tetracycline and streptomycin, 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. Banthorpe 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 Publishers.
4. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers.
5. New Trends in Natural Product Chemistry, Att – U.R.– Rahman and M.I. Choudhary, Harwood, Academic Publishers.
6. Insecticides 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.



**FOURTH SEMESTER**  
**PAPER NO.- II**  
**CATALYSIS, MATERIAL AND NUCLEAR CHEMISTRY**

**MAXIMUM MARKS :80**

**NUMBER OF**

**UNITS : IV**

**UNIT I**

**ACID BASES, ELECTROPHILES, NUCLEOPHILES AND CATALYSIS:**

Acid-base dissociation, Electronic and structural effects, acidity and basicity. Acidity functions and their applications. Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The  $\alpha$ -effect. Ambivalent nucleophiles. Acid-base catalysis – specific and general catalysis. Bronsted catalysis, Enzyme Catalysis.

**UNIT II**

**MATERIAL CHEMISTRY:**

Preparation and Properties of Nanoparticles, Materials-Metals, Semiconductors, Ceramics (Oxide, carbides, sulphides, nitrides). Physical and Chemical methods. Reduction method, size and shape controlled synthesis, Sol-gel methods, Optical properties, Electrical and Magnetic properties, Application of Nanoparticles.

**UNIT III**

**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 delayed neutrons, liquid drop model of nuclear fission.

**NUCLEAR ENERGY:**

Nuclear fission, chain reaction, multiplication factor, nuclear reactors.

**UNIT IV**

**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.

**DETECTION OF NUCLEAR RADIATIONS:**

Techniques, Equipments, G.M> counter, proportional counter, Scintillation counter, Counting Statistics.

**BOOK SUGGESTED:**

1. Nuclear and Radiochemistry by G. Friedlander, J.W. Kennedy & J.M. Miller, John Wittey and Sons, in New York.
2. Source Book an Atomic Energy – S. Glasstone, Affiliated East – West Press Pvt. Ltd. New Delhi.
3. Nuclear Physics by I. Kaplan, Addison – Welsy, Publishing company lodon.
4. Nuclear Chemistry and its applications, M. Haissinsky, Addison – Welsley, Publishing Company, London.
5. Essentials of Nuclear chemistry, H.J. Arnika, Wiley Eatern Ltd. New Delhi.
6. Molecular Mechanics, U. Buukert and N.L. Allinger, ACS Monograph 177, 1982.
7. Organic Chemist's Books of Orbitals. L. Salem and W.L. Jorgensen, Acedemic Press.
8. Mechanism and Theory in Organic Chemistry, T.H. Lowry and K.C. Richrdson, Harper and Row.

**FOURTH SEMESTER**  
**PAPER NO. - III**  
**INSTRUMENTAL METHODS OF ANALYSIS**

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

**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 : Principles-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 generation 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.

## FOURTH SEMESTER

### PAPER NO. - IV

#### ENVIRONMENTAL & APPLIED CHEMICAL ANALYSIS

**MAXIMUM MARKS :80**

**NUMBER OF UNITS : IV**

#### 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<sub>2</sub>, NO<sub>x</sub>, SPM, VOC's, Pb, CO<sub>2</sub>, POP's, Hg, carbon and ozone air pollution control devices Viz ESP, scrubber technique, baghouse filters etc. Atmospheric chemistry of acid rains, photochemical smog, green house effect, global warming, ozone hole.

#### UNIT II

##### SOIL AND WATER POLLUTION

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

#### UNIT III

##### FOOD ANALYSIS

Moisture ash, crude protein, fat, crude fibre, carbohydrate, calcium, potassium, sodium and phosphate. Food adulteration: common adulterants in food, contamination of foodstuffs, microscopic examination of foods for adulterants, pesticides analysis in food products, HPLC, Gas chromatographic technique for analysis of organic phosphates in food products, TLC technique for identification of pesticides in food products.

#### UNIT IV

##### A. DRUG ANALYSIS:

Narcotics and dangerous drugs, classification of drugs, Mode of action of narcotics, Sedatives, Hypnotics and tranquilizers, Screening by gas and thin layer chromatography, spectrophotometric measurements.

##### B. CLINICAL ANALYSIS:

Concepts and principles of analytic methods commonly used in the clinical species: i.e. ammonia, blood urea Nitrogen, Ca, Cl, Co<sub>2</sub>, Fe, K, Li, Mg, Na, P, urea, glucose.

Method for analysis of proteins (i.e. albumin, bilirubin, creatinine, cholesterol, HDL-cholesterol, triglycerides, creatinine)

##### C. FUEL ANALYSIS:

Solid, liquid and gas fuels, ultimate and proximate analysis, heating values, grading of coal, liquid fuels, flash and fire point, octane number and carbon residue, gaseous fuels, producer gas and water gas, calorific value.

#### 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, Indushekar Thakur, I.K. International Pvt. Ltd.
19. Fundamental of Analytical Chemistry, D.A. Sloog, 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.

**FOURTH SEMESTER  
PRACTICAL NO.- I  
ORGANIC PRACTICAL**

**MAXIMUM MARKS :100**

**A MULTI-STEP SYNTHESIS OF ORGANIC COMPOUNDS:**

1. Beckmann Rearrangement: Benzanilide from benzene.  
(Benzene Benzophenone Benzophenone oxime Benzanilide)
2. Benzilic Acid Rearrangement: Benzilic acid from Benzoin  
(Benzoin Benzil Benzilic acid)
3. Skraup's synthesis (Synthesis of heterocyclic compounds)  
Quinoline from o - Amino phenol.
4. p - Bromoaniline from Aniline  
(Aniline Acetanilide p - Nitroacetanilide p - Bromoaniline)
5. p - Nitroacetanilide from Acetanilide  
(Aniline Acetanilide p - Nitroacetanilide p - Nitroaniline)
6. m - Nitroaniline from Benzene  
(Benzene Nitrobenzene m - dinitrobenzene m - nitroaniline)
7. Acridone from Anthranilic acid  
(Anthranilic acid o - Chlorobenzoic acid N - Phenylanthranilic acid Acridone)
8. 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:**

1. Estimation of Sulphur by Messenger's Methods.
2. Estimation of Nitrogen by Kjeldahl Method.

**C ESTIMATION OF FUNCTIONAL GROUP:**

1. Estimation of Aniline.
2. Estimation of Amino Group by Acetylation Method.
3. Estimation of Hydroxyl Group by Acetylation Method.
4. Estimation of Carbonyl Group by Hydrazone Formation Method.
5. Estimation of Carboxyl Group by Titration Method.
6. Determination of Equivalent Weight of Carboxylic Acid by Silver Salt Method.
7. Estimation of Glucose by Fehling Solution Method.
8. Estimation of Glycine by Titration Method.

**D EXTRACTION OF ORGANIC COMPOUNDS FROM NATURAL SOURCES:**

1. Isolation of Caffeine from leaves.
2. Isolation of Casein from milk.
3. Isolation of lactose from milk.
4. Isolation of nicotine dipicrate from tobacco.
5. Isolation of Cinchonine from cinchona bark.
6. Isolation of Piperine from black pepper.
7. Isolation of Lycopene from tomatoes.
8. Isolation of  $\beta$ - Carotene from carrots.
9. Isolation of Limonene from citrus rinds.
10. Isolation of protein and carbohydrates from seeds - colour test.
11. Extraction of Fatty oil from seeds and determination of refractive index of the oil.
12. Isolation of protein and carbohydrate (as reducing sugars) from seed-colour test.

**BOOK SUGGESTED:**

1. Practical Organic Chemistry, by A.I. Vogel/Mann and Saunders/Garg and Saluja.
2. The Systematic Identification of Organic Compounds, R.L. Shriner & D.Y. Curtin.

**FOURTH SEMESTER  
PRACTICAL NO.- II  
ANALYTICAL PRACTICAL**

**MAXIMUM MARKS :100**

**A TITRIMETRIC/GRAVIMETRIC DETERMINATIONS:**

1. Manganese in iron/Steel by Bismuthate/Lingane – Karplus/Periodate methods.
2. Manganese in Pyrolusite ores.
3. Nickel in steel by dimethylglyoxime method.
4. Lead by dithizone precipitation.

**B SPECTROPHOTOMETRIC DETERMINATIONS:**

1. Manganese/Chromium/Vanadium/Copper/Lead in Steel and Environmental/Industrial effluent samples.
2. Nickel/Molybdenum/Tungsten/Vanadium/Uranium by extractive spectrophotometric method.
3. Fluoride/Nitrite/Phosphate in tap/pond/river industrial wastewater.
4. Iron in water samples by thiocyanate and phenanthroline methods.

**C CHROMATOGRAPHIC SEPARATION:**

1. Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of R<sub>f</sub> values.
2. Thin layer chromatography – separation of nickel, manganese, cobalt and zinc, Determination of R<sub>f</sub> values.

**D FLOW INJECTION ANALYSIS:**

Determination of the following anions/cautions in synthetic/real/environmental samples.

1. Ca<sup>2+</sup>, Mg<sup>2+</sup>, Al<sup>3+</sup>, Mn<sup>2+</sup>, Cr<sup>6+</sup>, Fe<sup>3+</sup>.
2. F<sup>-</sup>, Cl<sup>-</sup>, PO<sub>4</sub><sup>3-</sup>, NO<sub>2</sub>, NO<sub>3</sub>, SO<sub>4</sub><sup>2-</sup>, BO<sub>3</sub><sup>3-</sup>.

**E ATOMIC ABSORPTION SPECTROPHOTOMETER:**

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

**F MISCELLANEOUS:**

1. Nutrient and micronutrient analysis in plant/soil/sediment.
2. Speciation of toxic metals i.e. As, Hg, Se, etc.
3. 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.