COURSES OF STUDIES

M.Sc. IN CHEMISTRY

SEMESTER-I and II

SEMESTER-III and III

The two year course in M.Sc chemistry shall comprise four semesters. There shall be twelve theory papers and eight practical papers. Each theory paper shall carry 50 marks and of 3 hours duration. Each practical paper shall carry 50 marks and of 6 hours duration.

Each theory paper shall carry three units. Questions will be set unit wise. Each unit will carry two questions. Students are required to answer three questions selecting one question from each unit.

PG-I

SEMESTER -I

Paper-I (CH.1.1.1)

INORGANICCHEMISTRY

FM-10+40 **Time: 1+3 hrs**

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. Symmetry point group. Schonflies symbols, Matrix representations of groups (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 uses: Vanishing integral rule and application to selection rules.

UNIT –II Metal -Ligand Equilibria in Solution

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

UNIT-III 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, Acid hydrolysis, factors affecting acid hydrolysis and base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate base mechanism, anation reactions, reaction without metal ligand bond cleavage. Substitution reactions in square planar complexes. The trans effect, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and, Marcus-Hush theory, Inner sphere type reactions.

Books Recommended:

1. Advanced Inorganic Chemistry: A Comprehensive Text: FA Cotton and G. Wilkinson, John Wiley.
2. Inorganic Chemistry: Principles of Structure and Reactivity: J.E. Huheey, E.A. Keiter and R.L. Keiter, Addition Wisley Publishing Company.
3. Comprehensive Coordination Chemistry eds.: G. Wilkinson, R.D. Gillars and JA McCleverty, Pergamon.
4. Chemical Application of Group Theory: FA Cotton, John Wiley.
5. Symmetry in Chemistry: Orchin and Jaffe.
6. Group theory: I .V. Raman, Tata McGraw Hill.
7. Advanced Inorganic Chemistry: FA Cotton, G. Wilkinson, C.A. Murillo and M. Bochmann, John Wiley and Sons.
8. Group Theory & its Applications to Chemistry: KV. Raman, Tata McGraw Hill Publishing Company, New Delhi.

PAPER-II (CH 1.1.2)

ORGANIC. CHEMISTRY

FM-10+40 **Time: 1+3 hrs**

UNIT-I

(A) Aromatic Electrophilic Substitution:

The areniun ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, Ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeier reaction, Gattermann- Koch reaction.

(B) Aromatic Nucleophilic Substitution:

The S_NAr, S_N^i benzyne and SR_N1 mechanisms. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

(C) Free Radical Reactions:

Types of free radical reactions: Free radical substitution, mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity.

Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction, free radical rearrangement, Hunsdiecker reaction.

UNIT-II Reaction Mechanism: Structure and Reactivity

(A) Types of mechanism, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin - Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases.

(B) Generation, structure, stability and reactivity of carbocations, carbanions, free radicals. Carbenes and nitrenes.

Effect of structure on reactivity: resonance and field effect, steric effect, quantitative treatment. The Hammett equation and linear free energy relationships, substitutent and reaction constants. Taft equation.

UNIT-III

(A) Aliphatic Nucleophilic substitution:

The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by σ and π bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations.

The S_N1 mechanism: Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.

Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

(B) Aliphatic Electrophilic Substitution:

S_E2 and S_E1 and S_Ei mechanism, electrophilic substitution accompanied by double-bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Books Recommended:

1. Organic chemistry: J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
2. Advanced Organic Chemistry Reactions, Mechanism and Structure: Jerry March. John Wiley and Sons.
3. Advanced Organic Chemistry: FA Carey and RJ. Sundberg. Plenum.
4. A Guide Book to Mechanism in Organic Chemistry: Peter Sykes, Longman/Pearson Education.

5. Structure and Mechanism in Organic Chemistry: CK Ingold. Cornell University Press.
6. Organic Chemistry: R T. Morrison and RN. Boyd. Prentice Hall/Pearson Education.
7. Modern Synthetic Reactions: Second Edition, H.O. House, Benjamin, Menlo Park, 1972.
8. Principles of Organic Synthesis: RO.C. Norman and J.M. Coxon. Blackie Academic and Professional / CBS Publishers.
9. A logical Approach to Modern Organic Chemistry: Dr. Jagdamba Singh and Dr. S. Anandvardhan. Pragati Prakasan.
10. Reaction Mechanism in Organic Chemistry: S. Mukherji and S.P. Singh, Macmillan.
11. Advanced Organic Chemistry: Reactions and Mechanism : B. Miller and R Prasad. Pearson-Education.
12. Stereochemistry of Organic Compounds : D. Nasipuri, New Age International.
13. Stereochemistry of Organic Compounds : P.S. Kalsi, New Age International.
14. Stereochemistry of Organic Compounds : E. L. Eliel and S. H. Wilen. John Wiley.
15. Stereochemistry, Conformation and Mechanism : P. S. Kalsi, New Age International.

PAPER-III (CH-1.1.3)

PHYSICAL CHEMISTRY

FM-10+40 **Time: 1+3 hrs**

UNIT-I: Quantum Chemistry

(A) Introduction to Exact quantum Mechanical Results:

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.

(B) 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.

(C) Electronic Structure of Atoms:

Electronic configuration. Russell-Saunders terms and coupling schemes, magnetic effects: spin-orbit coupling and Zeeman splitting.

(D) Molecular Orbital Theory:

Huckel theory of conjugated systems, bond order and charge density calculation. Applications to ethylene, butadiene, cyclopropenyl radical, and cyclobutadiene.

UNIT-II Thermodynamics

(A) Classical Thermodynamics

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties; partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities. Concept of fugacity and determination of fugacity.

(B) Non-ideal systems: Activity, activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients, ionic strength.

(C) Statstical Thennodynamics

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging, Canonical, grand canonical and microcanonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers)

Partition functions-translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition function.

Applications of partition functions. Heat capacity behaviour of solids - chemical equilibria and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, distribution law and application to metal. Bose-Einstein statistics - distribution law and application to helium.

UNIT-III Vibrational Spectroscopy:

(A) Infrared Spectroscopy:

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strength; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy, P. Q. R. branches. Breakdown of Oppenheimer approximation, vibrations of polyatomic molecules, Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities; far IR region, metal-ligand vibrations, normal co-ordinate analysis.

(B) 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 (RRS), Coherent Antistokes Raman Spectroscopy(CARS).

Books Recommended

1. Atkin's Physical Chemistry: P.W. Atkins,J.D. Paula, Oxford University Press
2. Introductory to Quantum Chemistry:4th Ed., AK Chandra, TataMc Graw Hill.
3. Quantum Chemistry: Ira N. Levine, Prentice Hall.
4. Coulson's Valence: R Mc Weeny, ELBS.
5. Physical Chemistry Vol-II: .RL. Kapoor, Mcmillan Publication.
6. Statistical Thermodynamics: M.C Gupta, New Age Pvt Publication.
7. Fundamentals of Molecular Spectroscopy : C.N. Banwell, McGraw-Hill.
8. Basic Principles of Spectroscopy: R. Chang, Mc Graw Hill.
9. Theory and Applications of U.V. Spectroscopy: H.H. Jaffe and M. Orchin, IBH-Qxford.
10. Quantum Chemistry : R K Prasad.

PAPER-IV (CH-1.1.4)

INORGANIC CHEMISTRY PRACTICAL

FM-10+40 **Time: 1+3 hrs**

1. Qualitative analysis of mixtures containing not more than six radicals , (organic acid radicals should be excluded, less common metal ions Mo, W, Ti, V, Zr, U (two metal ions in cationic / anionic forms), insoluble-oxides, sulphates and halides may be included]

2. Separation of cations and anions by (a) paper chromatography and column chromatography (b) ion exchange technique.

Books Recommended:

1. Vogel'-s Qualitative Inorganic Analysis (revised) : G. Svehla, Longman.

2. Inorganic Experiments: J. Derck Woollins, VCH.

3. Microscale Inorganic Chemistry: Z. Szafran, RM. Pike and M.M: Singh, Wiley.

4. Practical Inorganic Chemistry: G. Marr, B.W. Rockett Van Nostrand.

PAPER –V (CH-1.1.5)

ORGANIC CHEMISTRY PRACTICAL

FM-10+40 **Time: 1+3 hrs**

Separation, purification and identification of compounds of binary mixtures (solid-solid, solid-liquid, liquid-liquid) using TLC and column chromatography, Chemical tests.

Books Recommended :

1. Vogel'.s Text Book of Practical Organic Chemistry (revised): B.S. Furniss, A.J. Hannaford, V. Rogers, P.W.G. Smith and AR Tatchell, E.L.B.S., Longman.
2. Systematic Qualitative Organic Analysis: H. Middleton, Orient Longman.
3. A Hand Book of Organic Analysis (Qualitative and Quantitative): H.T. Clarke, Revised, B. Haynes, Arnold Publishers.
4. The Systematic Identification of Organic Compounds: R.L. Shriner, C. K. F. Harmann, T.C. Morrill, D.Y. Curtin, R.C. Fusion, John Wiley and Sons.
5. Organic Analytical Chemistry (Theory and Practice): Jagmohan, Narosa Publishing House.

PG-I

SEMESTER -II

PAPER – VI (CH-1.2.6)

INORGANIC CHEMISTRY

FM-10+40 **Time: 1+3 hrs**

UNIT-I Metal-Ligand Bonding

Crystal-Field Theories:

Limitation of crystal field theory, Elementary idea of Angular overlap model, molecular orbital theory for octahedral, tetrahedral and square planar complexes, σ and π bonding in molecular orbital theory.

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), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information.

Unit –III (A) Metal π -Complex.

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 and ligands.

(B) Metal Clusters

Higher boranes, carboranes, metalloboranes and, metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

Books Recommended:

1. Advanced Inorganic Chemistry: F.A, Cotton and G. Wilkinson, John Wiley.

2. Inorganic Chemistry: J.E. Huheey, E.A Keiter, RL. Keiter, Pearson Education.

3. Chemistry of the Elements: N.N.B. Greenwood and A Earnshow, Pergamon.

4. Inorganic Electronic Spectroscopy: AB. P. Lever, Elsevier.

5. Magnetochemistry, RL. Carlin, Springer Verlag.

6. Comprehensive Coordination Chemistry eds.,-G. Wilkinson, RD. Gillars and J.A. McCleverty, Pergamon.

PAPER -VII (CH-1.2.7)

ORGANIC CHEMISTRY

FM-10+40 **Time: 1+3 hrs**

UNIT-I: (A) Nature of Bonding in Organic Molecules

Delocalized chemical bonding: conjugation, cross conjugation, resonance, hyperconjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and nonbenzenoid compounds, alternant and non-alternant hydrocarbons. Huckel's rule, energy level of π-molecular orbitals, annulenes, antiaromaticity, ψ-aromaticity, homoaromaticity,PMO approach.

Bonds weaker than covalent addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, Catenanes and Rotaxanes.

(B) Stereochemistry

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

Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotropic and diastereotropic atoms, groups and faces, stereospecifjc and, steroselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.

Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

UNIT -II:

(A) Addition to Carbon-Carbon Multiple Bonds:

Mechanistic and stereochemical aspects of addition reactions involving electrophils, nucleophiles and free radicals, region and chemoselectivity, orientation and reactivity, Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration, Michael reaction. Sharpless asymmetric epoxidation.

(B) Addition to Carbon-Hetero Multiple Bonds:

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitiiles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction.

Mechanism of condensation reactions involving enolates, Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

(C) Elimination Reactions:

The E2, EI and E1cB mechanisms. Orientationof the double bond. Reactivity: Effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

UNIT -III PericyclicReactions:

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1, 3, 5 – hexatriene and allyl system. Classification of pericyclic reactions. WoodWard – Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions, conrotator and disrotatory motions; 4n, 4n+2 and allyl systems. Cycloadditions, antarafacial and suprafacial additions; 4n and 4n+2 systems, 2+2 addition of ketenes. 1, 3 - dipolar cycloadditon 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. Fluxional tautomerism. Ene reaction.

Books Recommended:

1. Advanced Organic Chemistry; Reactians Mechanism and Structure: Jerry March, John.Wiley.
2. Advanced Organic Chemistry: F A Carey and R J. Sundberg, Plenum.

3. A Guide Book to Mechanism in Organic Chemistry: Peter Sykes, Longman/Pearson Education.
4. Structure and Mechanism in Organic Chemistry: C K Ingold, Cornell University Press.
5. Organic Chemistry: R. T. Marrisan and R. N Boyd, Pentice- Hall/Pearson Education.
6. Modern Organic Reactians: H.O. House, Benjamin.
7. Principles of Organic Synthesis: R.O.C. Norman and J.M. Coxon, Blackie Academic & Professianal/ C.B.S. Publishers.
8. Pericyclic Reactians : S.M. Mukherji. Macmillan, India Ltd.
9. Reactian Mechanism in Organic Chemistry: S..M. Mukherjee and S.P. Singh, Macmillian. India. Ltd.
10. Organic Chemistry: J. Clyden, N. Grieves, S. Warren and P.Wather, Oxfard University Press.
11. Organic Reactians and Orbital Symmetry: T.L Gilchrist and R. C. Storr, Cambridge at the University Press.
12. Photo Chemistry and Pericyclic Reactians : Jagdamba Singh and Jaya Singh, New Age Internatianal.
13. Mechanism and Theory in Organic Chemistry: Thomas H. Lowry, Additian Wesley.

PAPER VIII (CH-1.2.8)
PHYSICAL CHEMISTRY

FM-10+40 **Time: 1+3 hrs**

UNIT –I Chemical Dynamics :

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactians, kinetic salt effects. steady state kinetics, kinetic and thermadynamic control of reactions. Treatment of unimolecular reactians.

Dynamics chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen -bromine and hydrogen - chlorine reactions) and oscillatory reactions (Belousov- Zhabotinski reaction), homogeneous catalysis, kinetics of enzyme reactions. general features of fast reactions, study of fast reactions by flow

method, relaxation method. flash photolysis and the nuclear magnetic resonance method. Dynamics of barrielless chemical reactions in solution, dynamics of unimolecular reactions (Lindemann- Hinshelwood and Rice Rampsberger - Kassel Marcus (RRKM) theories of unimolecular reactions).

UNIT-II Surface Chemistry :

(A) Adsorption:

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation). Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electrokinetic phenomenon), catalytic activity at surfaces.

(B) Micelles:

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentraion (CMC), factors affecting the CMC of surfactants counter ion binding to micelles, thermodynamics of micellization, phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

(C) Macromolecules:

Polymers -definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Molecular mass, number and 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.

UNIT-III Electrochemistry:

Electrochemistry of solutions. Debye-Huckel-Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Jerrum model. Thermodynamics of electrified interface equations. Derivation of electrocapiliarity; Lippmann equations (surface excess), methods of determination, Structure of electrified. interfaces,

Over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plol Qauntum aspects of charge transfer at electrode - solution interfaces, quantization of charge transfer, tunneling. semiconductor, interfaces-theory of double layer at

semiconductor-electrolyte solution interfaces, structuer of double layer interfaces. Effect of light at semiconductor solution interface.

Electrocatalysis-influence of various parameters, Hydrogen electrode.

Bioelectrochemistry, Thereshold membrance phenomena, Nerst-Planck equation, Hodges-Huxley equations, core conductor models, electrocardiography. Polarography theory, IIkovic equation; half wave potential and its significance.

Books Recommended:

1. Physical Chemistry: P.W. Atkins, J.D. Paula, Oxford III University Press.
2. Introduction to Quantum Chemistry : A.K.Chandra, Tata Mc Graw Hill.
3. Quantum-Chemistry : Ira N. Levine, Prentice Hall.
4. Coulson's Valence: R Mc Weeny, ELBS.
5. Chemical Kinetics: K.J.Laidler, McGraw-Hill.
6. Kinetics and Mechanism of Chemical Transformation: J.Rajaraman and J.Kuriacose, Mc millan.
7. Micelles, Theoretical and Applied Aspects, V.Moroi, Plenum.
8. Modem Electrochemistry: Vol.-I and Vol. II, J.O.M. Bockris and A.K. N. Reddy, Plenum.
9. Introduction to Polymer Science: V.R Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.
10. An Introduction to electrochemistry: S. Glasstone, Affiliated East-West Press Pvt. Ltd.

PAPER-IX (CH-1.2.9)

INORGANICCHEMISTRYPRACTICAL

F M- 10 + 40 **Time- 6 hr**

1. Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe etc. involving volumetric and gravimetric methods.

2. Preparation of some selected inorganic compounds and their study. Handling of air and moisture sensitivecompounds.

a) $Mn(acac)_3$

b) $K_3[Fe(C_2O_4)_3$.

c) $[Ni\ (NH_3)_6]\ Cl_2$

d) [$Ni(dimg)_2$.

e) $[Cu\ (NH_3)_4].\ SO_4.H_2O$

f) Cis - and Trans $[Co\ (en)_2]Cl_2$.

Books Recommended :

1. Inorganic Experiments: J. Derck Woollins, VCH.
2. Microscale Inorganic-chemistry; Z.Szafran, RM. Pike and M.M.Singh. Wiley.
3. Practical Inorganic Chemistry: G.Marr and B.W. Rockett, van,Nostrand.

PAPER-X (CH-1.2.1 0)

ORGANIC CHEMISTRY PRACTICAL

FM. – 10+ 40 **Time- 3+ 6 hrs.**

Quantitative Analysis:

1. Determination of amino group by acetylation method.
2. Detennination of hydroxyl group bya cetylation method.
3. Estimation of Keto group.
4. Determination of iodine value and saponification value of an oil sample.

5.Organic Synthesis: Preparation of adipic acid, p-chlorotoluene, p-nitroaniline, p-bromoaniline, triphenylmethanol.

BooksRecommended:

1. A Text Book of Practical Organic Chemistry :Arthur I.Vogel, .E.L.B.S. and Longman.
2. Vogel's Text Book of Practical Organic Chemistry: Revised, B.S. Furniss, A J. Hannaford, P.G. Smith and AR. Tatchell, Longman.
3. Experiments and Techniques in Organic Chemistry: D. Pasto, C. Johnson.

4. Organic Analytical Chemistry (Theory and Practice) : Jagmohan, Narosa publishing House.
5. Laboratory Mannual of Organic Chemistry: B.B. Dey and M.V.Siaram (Revised)-:T.R.Govindachari, Allied Publishers.