



**UNIVERSITY OF LUCKNOW
LUCKNOW
M.Sc. CHEMISTRY**

Programme Outcomes

- PO-1.** Demonstrate, solve and an understanding of major concepts in all disciplines of Chemistry independently and in group as well as draw logical conclusions through Project and Seminar Presentation.
- PO-2.** Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of Chemistry experiments
- PO-3.** Equip students to face the employment challenges and instil confidence to turn into entrepreneur and also step into research career.
- PO-4.** Generation of new scientific insights or to the innovation of new applications of chemical research
- PO-5.** Present scientific and technical information resulting from laboratory experimentation in both written and oral formats.
- PO-6.** Apply modern methods of analysis to chemical systems in a laboratory setting.
- PO-7.** The students will become well versed in the mechanisms of all types of high level and complicated chemical reactions.
- PO-8.** The students will improve their competencies on par with their counterparts in premier institutions across the nation.

Programme Specific Outcome

- PSO-1.** Appreciates the importance of various elements present in the periodic table, coordination chemistry and structure of molecules, properties of compounds, structural determination of complexes using theories and instruments.
- PSO-2.** Gathers attention about the physical aspects of atomic structure, dual behaviour, reaction pathways with respect to time, various energy transformations, molecular assembly in nanolevel, significance of electrochemistry, molecular segregation using their symmetry.
- PSO-3.** Learns about the potential uses of analytical, industrial chemistry and medicinal chemistry.
- PSO-4.** Understand and apply principles of Organic Chemistry for understanding the scientific phenomenon in Reaction mechanisms, Stereochemistry, Organic Synthesis, complex chemical structures, instrumental method of chemical analysis, molecular rearrangements and separation techniques.
- PSO-5.** Study of organometallic reactions.
- PSO-6.** Study of biological mechanisms using amino acids.
- PSO-7.** Learn the classical status of thermodynamics.
- PSO-8.** Carry out laboratory experiments taught in Core Theory papers and to understand good laboratory practices with safety.
- PSO-9.** Enhance studentsqability to develop mathematical models for physical systems.
- PSO-10.** Global level research opportunities to pursue Ph.D. programme targeted approach of CSIR/UGC . NET examination
- PSO-11.** Discipline specific competitive exams conducted by service commission



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PROGRAMME STRUCTURE

The Master of Science in Chemistry is a Two Year Full Time Course consisting of Four Semesters.

Semester I

Semester II

Semester III

Semester IV

COURSE STRUCTURE

Semester	Core Course			Elective Course			Open elective Course			Value Added		Total Credits	
	No. of Papers	Credits (L+T/P)	Total Credits	No. of Papers	Credits (L+T/P)	Total Credits	No. of Papers	Credits (L+T/P)	Total Credits	No. of Papers	Credits		
I	3	12+12	24	0	0+0	0	0	0+0	0	1	4	28	
II	3	12+12	24	0	0+0	0	0	0+0	0	0	0	24	
III	3	12+04	16	1	4+0	4	1	4+0	4	0	0	24	
IV	1D	8+4	12	2	8+0	8	0	0+0	0	0	0	20	
Total Credits			76				12				4	4	96



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Semester IV Syllabus

Paper Code CCTP-10: Project and Dissertation (CH-401)

Credits 8

MM 200 (150+50)

Course Outcome:

- CO-1.** students will be able to plan and strategize a scientific problem, and implement it within a reasonable time frame.
- CO-2.** It is expected that after completing this project dissertation, students will learn to work independently and how to keep accurate/readable record of assigned project.
- CO-3.** In addition, students will be able to know the library search and handle the data in a meaningful way.
- CO-4.** Also, students will be able to interpret the spectral data independently.
- CO-5.** Subsequently, the students should be able to critically examine research articles, and improve their scientific writing/communication skills and power point presentation.

For project work and dissertation, the area of the work would be to be decided by the advisor/mentor. On completion of the project work, students have to submit the work in the form of a dissertation followed by oral presentation in the presence of faculty members.



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Unit IV

Supramolecular Chemistry-I

- a. Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of coreceptor molecules and multiple recognition.
- b. Transport processes and carrier design.

Unit V

Supramolecular Chemistry-II

- a. Supramolecular reactivity and catalysis.
- b. Supramolecular devices. Supramolecular photochemistry, supramolecular electronic, ionic and switching devices.

Recommended Books:

1. Outlines of Biochemistry, E. E. Conn and P. K. Stumpf, John Wiley.
2. Macromolecules: Structure and Function, F. Wold, Prentice Hall.
3. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
4. Bioinorganic Chemistry, I. Bertini, H. B. Gray, S. J. Lippard and J. S. Valentine, University Science Books.
5. Inorganic Biochemistry vol. I and II. ed. G. L. Eichhorn, Elsevier.
6. Supramolecular Chemistry, J. W. Steel and J. L. Atwood
7. Bioinorganic Chemistry, K. H. Reddy, New Age.



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Semester IV Syllabus

Paper Code CCEP-2: Organotransition Metal Chemistry (CH-402B)

Credits 4

MM 100 (70+30)

Hours 60

Course Outcome:

- CO-1.** To know and understand the different properties and structures for organometallic compounds from different parts of the periodic table and their trends.
- CO-2.** To know principal synthetic routes to various classes of organometallic compounds.
- CO-3.** know and understand the reactivity of organometallic compounds including their application in synthesis.
- CO-4.** To know methods and examples for the study of organometallic compounds in the gas phase, solution phase and solid state.
- CO-5.** To know common ligand classes in organometallic chemistry, their effects on organometallic compounds, and influence on reactivity and catalysis.
- CO-6.** To know and understand key mechanistic steps in reactions involving organometallic compounds.
- CO-7.** Students will learn about synthetically useful transformations including oxidations, reductions, enolate reactions, pericyclic reactions, organometallic reactions, and reactions of electron deficient species. The emphasis will be on developing a mechanistic understanding of selectivity and synthetic strategy.

Unit I

Compounds of Transition Metal-Carbon Multiple bonds

Alkylidenes, alkylidyne, low valent carbenes and carbenes . synthesis, nature of bonds, structural characteristics, nucleophilic and electrophilic reactions on the ligands.

Transition Metal Compounds with Bonds to Hydrogen

Covalent hydrides: synthesis and important reactions.

Unit II

Transition metal δ -Complexes with unsaturated organic molecules

Alkenes, alkynes, allyl, dienes, dienyl and arene complexes . preparations, properties, nature of bonding and structural features. Important reactions related to nucleophilic and electrophilic attack on ligands.

Unit III

Transition Metal Compounds with Bonds to Carbon in Catalysis

General idea of important catalytic steps: ligand coordination and dissociation, insertion and elimination, nucleophilic attack on coordinated ligands, oxidative addition and reductive elimination reactions.

Unit IV

Homogeneous Catalysis

Hydrogenation of alkenes using Wilkinson's catalyst, Hydroformylation of alkenes using Co and Rh catalysts, Carbonylation of methanol to acetic acid (Monsanto process), Oxidation of alkenes (Wacker process)



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Unit V

Fluxional Organometallic Compounds

Fluxionality and dynamic equilibria in compounds such as η^2 -olefine, η^3 allyl and dienyl complexes.

Organometallic Compounds of Lanthanides and Actinides

Methods of preparation, properties and structural features.

Recommended Books:

1. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley
2. Inorganic Chemistry, J. E. Huheey, Ellen A. Keiter, Richard L. Keiter, Addison Wesley Longman (Singapore) Pvt. Ltd.
3. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw, Pergamon.
4. Organometallic Chemistry: A Unified Approach, R. C. Mehrotra and A. K. Singh, New Age
5. Principles of Organometallic Chemistry, G. E. Coates, M. L. H. Green, P. Powell and K,
6. Wade, Chapman and Hall, London.



**UNIVERSITY OF LUCKNOW
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Semester IV Syllabus

Paper Code CCEP-3: Organic Synthesis (CH-403A)

Credits 4

MM 100 (70+30)

Hours 60

Course Outcome:

On completion of the course, the student should be able to:

- CO-1.** describe methods for synthesis and transformation of the most common functional groups
- CO-2.** describe and apply stereochemical concepts such as chirality, stereoisomerism, and stereoselectivity in relation to chemical transformations
- CO-3.** identify, analyse and evaluate synthetic routes to target molecules using retrosynthesis
- CO-4.** apply organometallic reagents and reactions in organic synthesis
- CO-5.** Will learn the multistep synthesis of complex molecules
- CO-5.** Plan and design experimental setups for various types of laboratory tests, perform transformations of importance for organic synthesis, perform basic risk assessment and document laboratory work in the form of laboratory journal.
- CO-6.** give oral and written accounts on the content and results of the laboratory practicals.

Unit I

Oxidation

Introduction. Different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides. Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate.

Unit II

Protecting Groups

Principle of protection of alcohol, amine, carbonyl and carboxyl group

Ring Synthesis

Saturated heterocycles, synthesis of aziridines, oxiranes, thiiranes, azetidines, oxetane, thietane, pyrones, pyrroles, indole, isetan, coumarin and quinoxaline.

Unit III

Reduction

Introduction. Different reductive processes. Hydrocarbons-alkanes, alkenes, alkynes and aromatic rings. Carbonyl compounds-aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups.

Disconnection Approach

Introduction to synthons and synthetic equivalents, disconnection approach, functional group interconversions, the importance of the order of the events in organic synthesis.

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalized compounds, α,β -unsaturated carbonyl compounds, difunctionalized compounds. Michael addition and Robinson annelation.



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Unit IV

Rearrangements

General mechanistic considerations . nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements-Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schimdt, Baeyer-Villigr, Shapiro reaction.

Unit V

Synthesis of Some Complex molecules

Application of the above in the synthesis of following compounds: Camphor, Longifoline, Cortisone, Reserpine, Vitamin D, Juvabione, Aphidicolin and Fredericamysin A.

Recommended Books:

1. H.O. House, Synthetic Organic Chemistry, Benjamin-Cummings Publishing Co.
2. Organic Chemistry J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford Press.
3. Organic Synthesis, Pragati Edition, Jagdamba Singh and L.D.S Yadav.
4. Some modern methods of organic synthesis, W. Carruthers, Cambridge University Press.
5. Organic Reactions And Their Mechanisms, P. S. Kalsi, New Age Science.
6. Workbook for Organic Synthesis, Stuart Warren, John Wiley & Sons.
7. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons.
8. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Nomenclature and Chemistry of three to five membered Heterocycles), Elsevier publication.
9. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Chemistry of six to eight membered N, O, S, P and Se heterocycles), Elsevier publication.



**UNIVERSITY OF LUCKNOW
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Semester IV Syllabus

Paper Code CCEP-3: Medicinal Chemistry (CH-403B)

Credits 4

MM 100 (70+30)

Hours 60

Course Outcome-

After completing the course, students shall be able to-

CO-1. describe the drug design, action of drug

CO-2. describe the concept of receptors, thermokinetics and thermodynamics

CO-3. describe the antineoplastic agents, cardiovascular agents and psychoactive agents and antibiotics.

CO-4. describe the various stages involved in the development of a drug,

CO-5. describe the "interaction between ligand and receptor" concept

CO-6. identify and describe the connection between chemical structure and physical-chemical properties,

CO-7. describe the design of organic compounds, for example, statistical or structure-based design

CO-8. plan and conduct a medicinal chemistry project,

CO-9. independently acquire and critically assess biological and medicinal information from databases

CO-10. actively participate in discussions during seminars and group exercises,

CO-11. present results verbally and in writing, and

CO-12. communicate principles, problems and research results with specialists and non-specialists on issues within the scope of the content of the course.

Unit I

Drug Design

Cell signaling and diseases: Definition of Inter and intracellular signaling pathways, first and second messengers, receptors, effectors, signal transduction enzymes.

Drugs: Drug and type of pharmacological actions: Structurally nonspecific drugs; Structurally specific drugs, Drugs that do not act on receptors. Classification of drugs: natural, synthetic and biologics with examples.

Action of drug: Route of administration, binding of drugs to plasma protein binding and blood cells, First pass metabolism, biliary excretion and enterohepatic cycle, drug transport: Passive diffusion, Carrier Mediated transport, Transporter protein, Efflux pump via P-glycoprotein.

Drug design: Five stages of drug discovery and development, Definition of hit and lead molecules, General practices in medicinal chemistry: Targets including validation, chemical library, screening: in vitro, in vivo, in silico, model organisms and phenotypic screening. Source for hit molecules: serendipity, endogenous source (hormones, monoclonal antibodies, microbial), Plants as traditional source, rational approach based on fragment based drug discovery and repositioning of drugs. Lead optimization: structure-activity and property relationship studies, structural and functional group modifications, structure-based drug design, Bioisosterism and stereoisomerism, prodrugs, $\%Me$ too+ strategies. Quantitative structure-activity relationship (QSAR): Hansch Analysis and Related Approaches

Physico-chemical properties of compounds (MW, solubility, lipophilicity: logP and D, pK_a , rule of five and three), drug-likeness and their role in drug design.

Case study: Rise of captopril, discovery of Taxol and Metformin



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Unit II

Concept of receptors: Cell surface (GPCR, enzyme linked and ion channels) and intracellular receptors, drug-receptor theories, and spare receptors.

Pharmacokinetics: Definition of ADME, Affect of physiological barriers on ADME: Gut, liver, systemic circulation, aqueous and lipid environment, Affect of physicochemical properties of compounds on ADME, Phase I and II drug metabolism and pharmacokinetic drug-drug interaction, Elementary kinetics of ADME: concentration-time curve and its parameters, bioavailability, volume of distribution, clearance, Elementary One and two compartment models.

Pharmacodynamics: Biochemistry of enzymes: Enzymes as biocatalysts, binding and catalytic sites, cofactor: Apoenzyme and Holoenzyme, enzyme- substrate complex, Michaelis-Constant and Michaelis-Menten equation.

Effect of inhibitors on enzyme activity: Reversible, competitive, noncompetitive and uncompetitive inhibitors.

Elementary drug-receptor complex formation and dissociation, drug-receptor binding parameters, drug- affinity, -efficacy and -potency, agonists and antagonists.

Pharmacodynamic drug-drug interaction

Unit III

Antineoplastic Agents

Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards, and 6-mercaptopurine. Recent development in cancer chemotherapy. Hormone and natural products.

Unit IV

Cardiovascular Drugs

Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output. Direct acting arteriolar dilators. Synthesis of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolol, oxyprenolol

Local Antiinfective Drugs

Introduction and general mode of action. Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, norfloxacin, dapson, amino salicylic acid, isoniazid, ethionamide, ethambutal, fluconazole, econazole, griseofulvin, chloroquin and primaquin.

Unit V

Psychoactive Drugs-The Chemotherapy of mind

Introduction, neurotransmitters, CNS depressants, general anaesthetics, mode of action hypnotics, sedatives, anti-anxiety drugs, benzodiazepines, buspirone, neurochemistry of mental diseases. Antipsychotic drugs-the neuroleptics antidepressants, butyrophenones, serendipity and drugs development, stereochemical aspects of psychotropic drugs. Synthesis of diazepam, oxazepam, chlorazepam, alprazolam, phenytoin, ethosuximide, trimethadione, barbiturates, thiopental sodium, guletehimide.

Antibiotics

Cell wall biosynthesis, inhibitors, -lactone rings, antibiotics inhibiting protein synthesis. Synthesis of penicillin G, ampicillin, amoxicillin, chloramphenicol, cephalosporin, tetracycline and streptomycin.



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Recommended Books:

1. Medicinal Chemistry, D. Sriram, P. Yogeeswari, Pearson Education.
2. Medicinal Chemistry, Ashutosh Kar, New Age International (P) Limited.
3. An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press.
4. Textbook of Medicinal Chemistry, V. Alagarsamy, Elsevier Health Sciences.
5. The Practice of Medicinal Chemistry, Camille G. Wermuth, Elsevier Health Sciences.
6. Drug-like Properties: Concepts, Structure Design and Methods: From ADME to Toxicity Optimization, Edward H Kerns, Li Di, Elsevier Health Sciences.
7. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Nomenclature and Chemistry of three to five membered Heterocycles), Elsevier publication.
8. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Chemistry of six to eight membered N, O, S, P and Se heterocycles), Elsevier publication.



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**Semester IV Syllabus
Paper Code CCEP-4: Polymer Chemistry (CH 404A)
MM 100 (70+30)**

Credits 4

Hours 60

Course outcome

Students will learn to

- CO-1.** define related concepts of polymers.
- CO-2.** summarize historical evolution of the polymers.
- CO-3.** recognize monomers and polymers.
- CO-4.** evaluate the structure of polymers.
- CO-5.** recognize bonds between polymer chains.
- CO-6.** debate thermal character and affecting factors of thermal behaviours.
- CO-7.** use determining method of molecular weights.
- CO-8.** categorize polymers.
- CO-9.** explain polymers production processes.

Unit I

Polymerisation reaction

Stepgrowth Polymerization: Theory of reactivity of large monomeric molecules, ring formation vs. chain formation. Polymerization: Chain Reaction, Free radical, Cationic, Anionic and living polymers. Coordination and co-polymerization. Polymerization conditions and polymer reactions. Three dimensional network polymerisation.

Unit II

Polymer Characterisation

Analysis and testing of polymers; chemical analysis, IR and NMR of polymers. X-ray diffraction study. Microscopy. Thermal analysis and physical testing hardness, tensile strength. Fatigue, impact, Tear resistance and abrasion resistance.

Unit III

Structure and Properties

Morphology and order in crystalline polymer-configurations of polymer chains. Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and property relationship. Melting point (T_m), effect of chain flexibility and other steric factors. Entropy and heat of fusion. The glass transition temperature (T_g), Relationship between T_m and T_g . Polymer structure and property relationship.

Unit IV

Polymer processing

General ideas about elastomers, plastics and fibres. Compounding and vulcanization of elastomers. Processing techniques: Calendaring, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming and reinforcing and fibre spinning.

Unit V

Some Commercial and Speciality Polymers

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins silicone and PTFE polymers. Speciality polymers: Fire retarding polymers and



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electrically conducting polymers, liquid crystal polymer. Biomedical polymers . contact lens, dental, artificial heart, kidney, skin and blood cells . polymers.

Recommended Books:

1. Textbooks of Polymer science, F.W. Billmeyer, Jr. Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Vishwanathan and J. Sreedhar, Wiley-Estern.
3. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Otanbrite.
4. Contemporary Polymer Chemistry, H. R. Alcock and F.W. Lambe, Prentice hall.
5. Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.



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Semester IV Syllabus

**Paper Code CCPP-8: Advanced Chemistry Practical-II (CH-405)
Credits 4 MM 100 (50+50)**

Note: Practical will be done based on the selected elective paper.

Course Outcome:

In order to make students understand the theories taught to them in M.Sc. semester (IV) in

different branches of chemistry e.g. Inorganic, Organic and Physical, the following practicals are introduced. Students will learn:

- CO-1.** Inorganic preparations in aqueous and organic medium.
- CO-2.** Colorimetric and spectrophotometric analysis.
- CO-3.** Three steps synthesis and identification of organic compound by their spectral data
- CO-4.** The basic knowledge like preparation of solution, standardization of secondary solution, dilution, calibration and handling of some sophisticated electronic related to the practical syllabus.
- CO-5.** The basic knowledge of kinetics by conductance method, pH determination pk value determination, spectrophotometer experiment, Cryoscopy method and Refractometry.
- CO-6.** To focus their aim for future prospects of Ph.D. programme and Pharmaceutical Industries.

INORGANIC CHEMISTRY

Inorganic preparation in aqueous and organic medium:

- (i) Preparation and complete analysis of $K_3[Fe(C_2O_4)_3].3H_2O$
- (ii) Preparation and separation of **cis** and **trans** . $[Co(en)Cl_2]$
- (iii) Preparation of $CuCl_2$. DMSO and Copper glycine complex.
- (iv) Preparation of Ph_3P and its complexes.
- (v) Preparation and reactions of ferrocene.
- (vi) Preparation of $Mn(gly)_3$

Colorimetric and Spectrophotometric analysis: Determination of iron, copper, ammonium, phosphate, fluoride and nitrite ions.

ORGANIC CHEMISTRY

Three steps synthesis incorporating various name reactions.

Identification of organic compounds by using their spectral data (UV, IR, 1H & ^{13}C -NMR and Mass Spectroscopy)

PHYSICAL CHEMISTRY

Conductance Experiments:

1. Study of kinetics of reaction between ethyl acetate and sodium hydroxide (saponification) by conductance method.

E.M.F. Experiments:

2. Determine the pH values for given buffer systems using quinhydrone electrode.
3. Titrate given mixed acids pH- metrically and find out their strengths.
4. Find out pK values of given acids pH metrically.

Spectrophotometer experiments



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5. Determination of stability constant of a metal ligand complex by spectrophotometric method.
6. Investigation of reaction between potassium per-sulphate and potassium iodide by spectrophotometer method.

Cryoscopic Method

7. Determination of molecular weight of a non-volatile solute by cryoscopic method (water/benzene).

Refractometry

8. Determination of the molar refractivity of methyl alcohol, acetic acid, ethyl acetate and carbon tetrachloride and calculate the refraction equivalents of carbon, hydrogen and chloride atoms.

Recommended Book:

1. Vogels Text book of Quantitative Analysis revised, J. Bessett, R.C. Denney, G.H. Jellery and J. Mendhan ELBS
2. Experimental Inorganic Chemistry by Mounir A, Malati, Horwood series in Chemical Science (Horwood publishing Chichester) 1999.
3. Inorganic Experiments, J. Derexwoolings VCH
4. Microscale Inorganic Chemistry, Z. Scafran, R.M. Pike and M.M. Singh Wiley.
5. Practical Inorganic Chemistry, G. Mairand, B.W. Rockett, Van Nostrand.
6. The systematic Identification of Organic Compounds, R.L. Shringer and D.Y. Curlin.
7. Qualitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Basic concept of Analysis chemistry, S.M. Chopkar, Wiley Bastern.
9. Synthesis and characterization of Inorganic compounds, W.L. Jolly, Prentice Hall.
10. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
11. Handbook of Organic Analysis Qualitative and Quantitative, H. Clark, Adward Ar.
12. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
13. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
14. Findley's Practical Physical Chemistry revised, B.P. Levitt, Longman.
15. Experimental Physical Chemistry, R.C. Das and Bebera, Tata Mc Grawhill.
16. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Barg (R. Chand and Co., Delhi)
17. Experimental Physical Chemistry by D.P. Shoemaker Mc Grawhill, 7th Edition 2003.
18. Experiments in Chemistry, D.V. Jahagirdar, Himalaya Publishing House.
19. Practical Physical Chemistry, B. Vishwanathan and P.S. Raghwan, Viva Books.
20. General Chemistry Experiments, Anil J Elias, University Press (2002)
21. Experimental Physical Chemistry, V.D. Athawale, Parul Mathur, New Age International (P) Limited.
22. Systematic Experiment in chemistry, Arun Sethi, New Age International (P) Limited.
23. Experiments in Physical chemistry, J.C. Ghosh, Bharati Bhavan.
24. Advanced Practical Physical Chemistry, JB Yadav.
25. Practical Organic Chemistry, Mann and Saunders.