DAYANAND COLLEGE HISAR

Affiliated to Guru Jambheshwar University of Science & Technology, Hisar
Under DAV College Managing Committee, New Delhi
(Accredited with Grade 'A' by NAAC)

Session: 2022-2023

DEPARTMENT OF CHEMISTRY

Programme Outcome, Programme Specific Outcome, Course Outcome

Department of Chemistry

Outcomes:

M.Sc. Chemistry

- **PO1**: Sound knowledge of fundamentals of Chemical Sciences.
- **PO2**: Understanding of multidisciplinary areas of physical sciences and their applications.
- **PO3**: Analytical skills through knowledge of various techniques for qualitative and quantitative analysis.
- **PO4**: Better approach using Green Chemistry methodologies in Chemical Sciences and industrial processes.
- **PO5**: Capability for design, synthesis, isolation, separation, purification and characterization of natural and synthetic compounds.
- **PO6**: Ability to gain chemical information from various sources through self-learning.
- **PO7**: Solving scientific and socio-economic problems.
- **PO8**: Understanding of hazards, safety data of materials for safe-guard of living beings and environment.
- **PO9:** Capability of drawing logical conclusion based on theoretical knowledge and practical observations.
- **PO10**: Effective communication, critical thinking, teamwork and ethics as a life-long learner.

Department of Chemistry

Programme Specific Outcomes:

M.Sc. Chemistry

After successful completion of TwoYears Degree Programme in M.Sc. Chemistry a student should gain the following skills:

PSO-1. Gain the knowledge of Chemistry through lectures, laboratory, tutorials and interaction with eminent academicians.

PSO-2. Develop laboratory skill for qualitative and quantitive analysis, organic synthesis, distillation, filtration, crystallization and chromatogrphy

PSO-3. To explain nomenclature, stereochemistry, structures, reactivity,

and mechanism of the chemical reactions. Identify chemical formulae and solve numerical problems.

PSO-4. Use modern chemical tools, advance instruments and Equipments.

PSO-5. Develop research oriented skills.

PSO-6. Understand safe working procedure, chemical toxicology, environmental concerns and handling of chemicals.

PSO-7. Kindle the urge for higher studies, entrepreneurship and lifelong learning.

Department of Chemistry

COURSE OUTCOMES

M.Sc. Chemistry

To teach fundamental concepts of Chemistry and their applications at undergraduate level, this will enable to impart comprehensive knowledge in Chemistry and its societal applications through a Two year programme. The syllabi of M.Sc. in Chemistry is arranged in such a manner that due importance is given to intellectual and laboratory skills according to UGC module based upon Choice Based Credit System (CBCS).

Name of Programme: M. Sc. Chemistry

Duration of Programme: Two Years (Four Semesters);

Choice Based Credit System (CBCS)SCHEME OF EXAMINATION

(w.e.f. 2022-2023)

Semester I

Course Code	Course Type	Course Name	Hrs/weekL - P	Credits	External Marks	Internal Marks	Total
ACL-511	Core	Inorganic Chemistry – I	4 - 0	4	70	30	100
ACL-512	Core	Organic Chemistry – I	4 - 0	4	70	30	100
ACL - 513	Core	Physical Chemistry-I	4 - 0	4	70	30	100
ACL - 514 (a) or ACL - 514 (b)	*Foundation Elective	Mathematics for Chemists or Chemistry of Life Science	2 - 0	2	70	30	100
ACP-501	Core	Inorganic Chemistry Practical – I	0 - 8	Annual Examination (Course spread over in semester I & II)			
ACP-502	Core	Organic Chemistry Practical – I	0 - 8				
ACP-503	Core	Physical Chemistry Practical – I	0 - 8				
		Total Credits		**14**			

* To be decided as per subject(s) (Mathematics/Biology) studied at B.Sc. level.

Semester II

Course Code	Course Type	Course Name	Hrs/week L - P	Credits	External Marks	Internal Marks	Total
ACL-521	Core	Inorganic Chemistry – II	4 - 0	4	70	30	100
ACL-522	Core	Organic Chemistry – II	4 - 0	4	70	30	100
ACL - 523	Core	Physical Chemistry-II	4 - 0	4	70	30	100
ACL - 524	Core	Group theory and Spectroscopy	4 - 0	4	70	30	100
ACP-501	Core	Inorganic Chemistry Practical – I	0 - 8	8	140	60	200
ACP-502	Core	Organic Chemistry Practical – I	0 - 8	8	140	60	200
ACP-503	Core	Physical Chemistry Practical – I	0 - 8	8	140	60	200
		Total Credits		**40**			

M.Sc. Chemistry

1st Semester

Inorganic Chemistry – I

Course code: ACL-511

60 Hrs (4Hrs /week)
Credits: 4
Time: 3 Hrs

Marks for Major Test (External): 70
Marks for Internal Exam: 30
Total Marks: 100

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the metal ligand bonding and chemistry of p block elements, Lanthanides, Actinides and non-aqueous solvent.

Unit - I **15 Hrs**

Theories of Metal -Ligand Bonding

Valence bond theory, electro neutrality principle and limitations, crystal field theory splitting of d-orbitals in cubic, octahedral, tetragonal, tetrahedral and square planar ligand environments. Structural consequences of splitting of d-orbitals, Limitation of crystal field theory, crystal field effects, John Teller distortion, nephelauxetic series, spin-orbital coupling, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without π -bonding).

Unit – II **15 Hrs**

Chemistry of Lanthanides and Actinides

Extraction and applications, color and spectra, magnetic properties, binary and ternary compounds, oxo salts, cyclopentadienyl compounds, Low oxidation state compounds, Lanthanide contraction, Use of lanthanide compounds as shift reagents.

General properties, oxidation states, dioxoions, chemistry of actinium, thorium, protactinium, uranium, uranyl and cyclopentadienyl compounds, transuranic elements, later actinide elements.

Unit – III **15 Hrs**

Chemistry of p-block Elements

Properties and special features of individual groups, synthesis, bonding and structure of halides and oxides of p-block elements, Synthesis, properties and structure of boranes, carboranes, borazines, silicates, phosphazenes, sulphurnitrogen compounds, oxy acids of nitrogen, phosphorus, sulphur and halogens, interhalogens, pseudohalides and compounds of xenon; metalloboranes and metallocarboranes.

Unit – IV **15 Hrs**

Non-aqueous Solvents

Solvent system definition, reactions in non-aqueous media with respect to sulphuric acid,ammonia, sulphur trioxide, bromine trifluoride, dinitrogen tetraoxide, hydrogen fluoride,

thionylchloride and phosphoryl chloride. Mechanism and kinetics of coordination reactions in non-aqueous media.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huheey and Harper Collins.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
4. Magnetochemistry, R.L. Carlin, Springer Verlog.
5. Inorganic Chemistry, G. Wulf'sburg.
6. Introduction to ligand fields, B.N. Figgis, Wiley Eastern.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Describe the theories of bonding in coordination compounds.

CO2 Explain the Chemistry of Lanthanides.

CO3 Explain the Chemistry of Actinides.

CO4 Discuss the synthesis, structure and properties of non-transition elements.

CO5 Describe the mechanism of coordination reactions in non-aqueous solvents.

M.Sc. Chemistry

1st Semester

Organic Chemistry -I

Course code: ACL-512

60 Hrs (4Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit andone compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the basic concepts of structure and reaction mechanism inorganic chemistry.

Unit-I
Nature of Bonding in Organic Molecules

Delocalized chemical bonding, cross conjugation, resonance, hyperconjugation, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Hückel's rule, annulenes, anti-aromaticity, homo-aromaticity. Bonding weaker than covalent – EDA Complexes, addition compounds, crown ether complexes and cryptates, inclusion compounds, cyclodextrins, catenanes and rotaxanes.

Unit -II
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, asymmetric synthesis (basic principle, auxiliary, substrate, reagent and catalyst controlled). methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes); Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

Unit -III
Reaction Mechanism: Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and react ion constants. Taft equation, kinetic and thermodynamic control, Hammond's postulate, Curtin - Hammett principle. Potential

energy diagrams, transition states and intermediates, methods of determining mechanisms, Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrene

Unit -IV

Aliphatic Nucleophilic Substitution

The S_N2, S_N1 and SET Mechanisms; The neighbouring group mechanism, neighbouring group participation by σ and π bonds; nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements; The SN^i mechanism. Nucleophilic substitution at an allylic carbon: allylic rearrangement, aliphatic trigonal carbon: the tetrahedral mechanism. Reactivity - effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase-transfer catalysis and regioselectivity.

Aliphatic Electrophilic Substitution

Bimolecular mechanisms – SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bound shifts. Effect of substrates, leaving group and the solvent polarity on thereactivity.

Books Suggested:

1. March's Advanced Organic Chemistry-Reactions, Mechanisms and Structure, Michael B.Smith and Jerry March, Wiley-Interscience.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Springer.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, CBC Publisher & Distributors.
5. Organic Chemistry, R.T. Morrison, R.N. Boyd and S. K. Bhattacharjee, Pearson.
6. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh revised by S.P.Singh and Om Prakash, Trinity.
7. Organic Chemistry, P.Y. Bruice, Pearson.
8. Organic Chemistry, J. Clayden, N. Geeves and S. Warren, Oxford University Press.
9. Organic Chemistry, T.W.G. Solomon, W.B. Fryhl and S.A. Snyder, Wiley.
10. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
11. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.
12. Stereochemistry of Organic Compounds, E.L. Eliel and S.H. Wilen, Wiley Interscience.
13. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Harcourt India Pvt. Ltd.

Course outcomes:

At the end of the course, the students would be able to:

CO1: Describe the aromaticity, anti-aromaticity, homo-aromaticity and non-covalent interactions in organic compounds.

CO2: Explain optical activity, chirality, methods of determining configuration and

asymmetric synthesis.

CO3: Describe methods of resolution, conformational analysis, stereospecific and stereoselective synthesis.

CO4 : Describe different methods for determining reaction mechanism.

CO5 : Analyze the structure, stability and reactivity of reaction intermediates

CO6 : Explain mechanistic details of various nucleophilic substitutions, elimination reactions.

M.Sc. Chemistry

1st Semester

Physical Chemistry-I

Course code: ACL-513

60 Hrs (4Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the basic concepts of thermodynamics and electrochemistry.

Unit -I

Classical Thermodynamics

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential in ideal gas mixture, determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential. Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solutions.

Unit -II **15 Hrs**

Statistical Thermodynamics

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, Determination and calculation of thermodynamic properties i.e. internal energy, entropy, Helmholtz and Gibbs free energy, ortho and para hydrogen states, free energy functions. Partition function and equilibrium constant, effect of nuclear spin, isomolecular reaction, isotopic exchange reactions. Einstein theory and Debye theory of heat capacities of monatomic solids.

Fermi-Dirac statistics, distribution law and applications to metal. Bose–Einstein statistics-distribution law and application to helium.

Unit -III **15 Hrs**

Electrochemistry-I

Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye - Falkenhagen effect, Wein effect. D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.

Electrified interface: Introduction, potential difference across electrified interfaces,

nonpolarizable interface and equilibrium, concept of surface excess; thermodynamics of electrified interfaces- interfacial tension, electro-capillarity curves, thermodynamic treatment of polarizable interfaces, Lippmann equation, determination of charge density on electrode.

Metal/Electrolyte interface, Concept of electrical double layer and its structure: Helmholtz- Perrin, Gouy-Chapman, and Stern models, electrokinetic phenomena, determination of zeta potential.

Unit -IV **15 Hrs**

Electrochemistry-II

Semiconductor-electrolyte interface– theory of double layer at semiconductor, Garrett-BrattainSpace Charge. Effect of light on semiconductor solution interface.

Electron transfer under interfacial electric field: exchange current density, over potentials, derivation of Butler-Volmer equation, Tafel plot.

Quantum aspects of charge transfer at electrodes-solution interfaces, quantization of charge transfer, tunneling.

Electrocatalysis– influence of various parameters. Hydrogen electrode. Polarography theory, Ilkovic equation, half wave potential and its significance.

Fuel Cells and Batteries: Energy conversion, theoretical consideration of fuel cells, maximum intrinsic efficiency, Hydrogen–Oxygen cell, Hydrocarbon –Air cells, Natural gas and Carbon mono- oxide-Air cells. Battery characteristics specification, components, battery systems, Lead storage battery, Dry cell, Silver-Zinc cell, Sodium –Sulphur cell, Ni-Cd and Li battery

Books Suggested:

1. Physical Chemistry, P.W. Atkins, Oxford University Press.
2. Physical Chemistry, G.W. Castellan, Narosa Publishers.
3. Introduction to Electrochemistry, S. Glasstone.
4. Modern Electrochemistry Vol.1 and Vol. II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
5. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press.
6. Chemical Thermodynamics, I.M. Klotz and R.M. Rosenberg, Benzamin.
7. Introduction to Chemical Thermodynamics, R. P. Rastogi and R.R. Mishra, Vikas Publication.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Understand the basic laws of thermodynamics and the related properties

CO2 Explain Debye-Huckel Theory for determination of activity & activity coefficients of electrolytic solution

CO3 Apply Statistical thermodynamics for energy distribution.

CO4 Elucidate the electrified interfaces and surface excess in electrochemical systems

CO5 Describe electrodic reactions and their rates.

CO6 Design and Set-up the fuel cells and batteries.

M.Sc. Chemistry

1st Semester

Mathematics for Chemists

Course code: ACL-514(a)

30 Hrs (2Hrs /week) **Marks for Major Test (External): 70**
Credits: 2 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the basic concepts of mathematics to be applied in chemistry.

Unit -I **8 Hrs**

Vectors and Matrix
AlgebraVectors
Vectors: dot, cross and triple products of vectors etc examples from angular momentum. The gradient, divergence and curl.
Vector calculus: Gauss Divergence theorem, Surface integral, Volume integral.
Matrix Algebra
Addition and multiplication; inverse, adjoint and transpose of matrices, special matrices (Symmetric, skew-symmetric, Hermitian, skew-Hermitian, unit, diagonal, unitary etc.) and their properties. Solution of Homogeneous, non-homogeneous linear equations and conditions for thesolution.

Unit -II **7 Hrs**

Matrix eigenvalues and eigenvectors, diagonalization, determinants (examples from Hückel theory).
Permutation, Probability and Curve Fitting
Permutations and combinations, probability and probability theorems, probability curves, average, root mean square and most probable errors, examples from the kinetic theory of gases etc., curve fitting (including least squares fit etc.) with a general polynomial fit.

Unit -III **7 Hrs**
Differential Calculus
Functions, continuity and differentiability, rules for differentiation, applications of differentialcalculus including maxima and minima (examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution etc), Exact and inexact differentials with their applications to thermodynamic properties.

Unit -IV **8 Hrs**
Integral Calculus and Elementary Differential Equations
Integral calculus, basic rules for integration, integration by parts, partial fraction and

substitution. partial differentiation, co-ordinate transformations.
Solutions of differential equations of first order by separation of variables Homogeneous, Linear and Exact equations. Applications to chemical kinetics, quantum chemistry etc. Solutions of differential equations by the power series method. Fourier series. The second order differential equations and their solutions.
Partial differential equation: introduction, formation of partial differential equation, solution of the partial differential equation, linear equation of the first order (Lagrange's equation), non linear equation of the first order.

Books Suggested:

1. The Chemistry Mathematics Book, E. Stener, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sucliffe, Longman.
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
4. Chemical Mathematics, D.M. Hirst, Longman.
5. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
6. Basic Mathematics for Chemists, Tebbutt, Wiley.
7. Differential equation, Schaum series, Tata McGraw Hill.
8. Elements of Partial Differential Equation, I.N.Sneddom, Tata McGraw Hill.
9. Vector Analysis, N. Ch. S.N- Iyengar, Anmol Publication Pvt Ltd.
10. Advanced Engg. Mathematics, E. Kreyszig, John Wiely & Sons.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Ability to understand the fundamentals of vector analysis

CO2 Capability to learn matrix algebra with its applications in chemical sciences

CO3 Understanding of probability ab initio

CO4 Fundamentals of differential calculus for use in chemical kinetics

CO5 Fundamentals of integral calculus for use in quantum chemistry

CO6 Understanding differential equations applied to chemical kinetics and quantum chemistry

M.Sc. Chemistry
1st Semester
Chemistry of Life Science

Course code: ACL-514(b)

30 Hrs (2Hrs /week) **Marks for Major Test (External): 70**
Credits: 2 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the basic concepts of biology related to chemistry.

Unit -I **8 Hrs**

Cell Structure and Metabolism

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic processes– catabolism and anabolism. ATP– the biological energy currency. Kreb's cycle, glycolysis, glycogenesis and glycogenolysis

Unit -II **7 Hrs**

Carbohydrates

Introduction, Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars-N-acetylmuramic acid and sialic acid, disaccharides. Structure and biological functions of Structural polysaccharides - cellulose and chitin. Storage polysaccharides -starch and glycogen. Heteropolysaccharides-glucosaminoglycans. Glycoconjugates- glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances.

Unit-III **7 Hrs**

Lipids

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins-compositionand function and role in atherosclerosis.
Properties of lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolism.

Unit-IV **8 Hrs**

Proteins and Nucleic acid

Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing, geometry of peptide linkage. Secondary structure- α-helix, β-sheets, super secondary structure, Tertiary structure, Quaternary structure of proteins. Various forces responsible for stabilization of protein structure.
Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of

nucleosides, nucleotides, double helix model of DNA and forces responsible for holding it.

Books Suggested:

1. Lehninger Principles of Biochemistry, M.M. Cox and D.L. Nelson, Freeman and Company.
2. Biochemistry, L. Stryer, W.H.F. Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E.E.Conn and P.K. Stumpf, John Wiley.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Explain about cells and their structure and functions overview of metabolic processes– catabolism and anabolism. ATP– the biological energy currency.

CO2 Explain the carbohydrates, their classification and carbohydrate metabolism - Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

CO3 Explain fatty acids, essential fatty acids, structure, function, their properties and lipid metabolism.

CO4 Explain protein (structure, hydrolysis of protein and forces responsible for structure of proteins) and our genetic material (DNA, RNA their structure and function)

M. Sc. Chemistry

2nd Semester

Inorganic Chemistry - II

Course code: ACL-521

60 Hrs (4Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with electronic spectra, charge transfer spectra, magnetic properties and reaction mechanism of transition metal complexes.

Unit- I **15 Hrs**

Electronic Spectra and Magnetic Properties of Transition Metal Complexes -I

Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols, vector diagrams to indicates coupling of orbital angular momenta in p^2, p^3, d^2 configurations and spin orbit coupling for p^2 arrangement, spectroscopic terms, spectral terms of d^2 to d^8 metal ions, determining the ground state terms -Hund's rules, derivation of the term symbol for a closed subshell.

Unit- II **15 Hrs**

Electronic Spectra and Magnetic Properties of Transition Metal Complexes -II

Interpretation of electronic spectra, Orgel diagrams, 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, anomalous magnetic moments, magnetic exchangecoupling and spin crossover.

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.

Unit - III **15 Hrs**

Reaction Mechanism of Transition Metal Complexes - I

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, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligandbond cleavage.

Unit – IV **15 Hrs**

Reaction Mechanism of Transition Metal Complexes- II

Substitution reaction in square planar complexes, the trans effect, theories of trans effect, Redox reactions or electron transfer reactions, complementary and non-complementary

reactions, mechanism of one electron transfer reactions, outer sphere type reactions, outer sphere mechanism, factors affecting rate of outer sphere reactions, inner sphere type reactions, bridge mechanism and its consequences, evidences in favour of bridge mechanism.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huheey, Harper Collins.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
4. Magnetochemistry, R.L. Carlin, Springer Verlog.
5. Introduction to Magnatochemistry, A. Earnshaw, Academic press.
6. Inorganic chemistry, G. Wulfsburg, University science books.
7. Introduction to ligand fields, B.N. Figgis, Wiley Eastern.
8. Organometallic Chemistry; R.C.Mehrotra and A.Singh, New Age International.
9. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J. Alexander; John Wiley.
10. The Organometallic Chemistry of the Transit ion Metals; R.H. Crabtree, John Wiley.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Interpret electronic spectra of transition metal complexes based on Orgel /Tanabe-Sugano diagrams and selection rules.

CO2 Discuss charge transfer spectra and magnetic properties of transition metal complexes.

CO3 Describe the stability of metal complexes.

CO4 Discuss the ligand substitution reactions and their mechanism.

CO5 Explain the mechanism of acid and base hydrolysis.

CO6 Describe trans effect, electron transfer reactions and mechanism.

M.Sc. Chemistry

2nd Semester

Organic Chemistry- II

Course code: ACL-522

60 Hrs (4Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the organic reaction mechanism including pericyclic reactions.

Unit-I **15 Hrs**

Aromatic Electrophilic Substitution

Theoretical treatment of aromatic substitution reactions, structure -reactivity relationship in mono substituted benzene ring, ipso attack, Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.

Aromatic Nucleophilic Substitution

Mechanism of Nucleophilic substitutions in aromatic systems. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

Elimination Reactions

The E2, E1 and E1cB mechanisms. Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium.

Unit-II **15 Hrs**

Free Radical Reactions

General aspects of generation, structure, stability and reactivity of free radicals, types of free radical reactions, effect of solvent on reactivity, halogenation including allylic halogenation, autooxidation, decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromatic substitution, Sandmeyer reaction and Hunsdiecker reaction.

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions involving electrophilies, nucleophiles and free radicals. Hydrogenation of double and triple bonds. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Unit-III **15 Hrs**

Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of carbonyl compounds, acids and esters. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl compounds. Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides.

Pericyclic Reactions-I

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 for Electrocyclic reactions, conrotatory and disrotatory motions, 4n, 4n +2 and allylsystems.

Unit-IV **15 Hrs**

Pericyclic Reactions- II

Woodward-Hoffmann correlation diagrams, FMO and PMO approach for Cycloaddition reactions, antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes. Sigmatropic rearrangements: antarafacial and suprafacial processes, Analysis of sigmatropic rearrangements of hydrogen and alkyl group, [3,3] and [5,5] rearrangements. Group transfer reactions and Ene reaction.

Books Suggested:

1. March's Advanced Organic Chemistry-Reactions, Mechanisms and Structure, Michael B.Smith and Jerry March, Wiley-Interscience.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Springer.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, CBC Publisher & Distributors.
5. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, Pearson.
6. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh revised by S.P.Singh and Om Prakash, Trinity.
7. Organic Chemistry, P.Y. Bruice, Pearson.
8. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
9. Pericyclic Reactions, S. Kumar, V. Kumar and S.P. Singh, Academic Press.
10. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Harcourt India Pvt. Ltd.
11. Organic Reaction Mechanism, V.K. Ahluwalia and R.K. Prasher, Narosa Publishing House.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Describe the aromatic and aliphatic electrophilic substitution reaction.

CO2 Explain the mechanisms of aromatic nucleophilic substitution including various rearrangements.

CO3 Describe the generation, structure, stability, reactivity of free radicals and addition to carbon-carbon multiple bonds.

CO4 Elucidate mechanism of reactions involving addition to C=O group of carbonyl compounds and acids.

CO5 Analyse the role of molecular orbitals in pericyclic reactions.

CO6 Determine the stereochemical course/product of a pericyclic reaction.

M.Sc. Chemistry

2nd SemesterPhysical Chemistry-II

Course code: ACL-523

60 Hrs (4Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit andone compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the basic concepts of Quantum Chemistry and Chemical Kinetics.

Unit – I **15 Hrs**

Quantum Mechanics-I

The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Schrodinger equation, eigen function and eigen values, free particle, Schrodinger equation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrodinger equation for linear harmonic oscillator and its solution, zero-pointenergy, Tunnelling Problem: Tunnelling through a rectangular barrier.

Unit – II **15 Hrs**

Quantum Mechanics-II

Energy levels and wave-functions of Rigid rotator. Hydrogen atom: Complete solution (separation of variables in spherical polar coordinates and its solution). Radial distributions.

Angular Momentum

Angular momentum, generalized angular momentum, eigenfunctions for angular momentum, eigenvalues of angular momentum.

Approximate Methods

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

Unit – III **15 Hrs**

Chemical Kinetics-I

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

Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen-bromine and hydrogen-chlorine reactions) and

oscillatory reactions (Belousov-Zhabotinsky reaction), homogenous catalysis, kinetics of enzyme reactions.

Unit – IV **15 Hrs**

Chemical Kinetics-II

Dynamics of unimolecular reactions (Lindemann–Hinshelwood and Rice - Ramsperger–Kassel–Marcus [RRKM] theories of unimolecular reactions). General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method.

Surface Chemistry

Adsorption: Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption equation, Langmuir adsorption isotherm and its kinetic derivation for non- dissociative and dissociativeadsorption, BET adsorption isotherm.

Books Suggested:

1. Physical Chemistry, P.W. Atkins, Oxford University Press.
2. Introductory Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, I.M. Levine, Prentice Hall.
4. Chemical Kinetics, K.J. Laidler, McGraw Hill.
5. Physical Chemistry, G.W. Castellan, Narosa Publishers.
6 Quantum Mechanics, M.L. Strause, Prentice – Hall.
7 Chemical Kinetics Methods, C. Kalidas, New Age International.
8. Physical Chemistry of Surfaces, Adamson, John Wiley & Sons.
9. Quantum Chemistry D.A. McQuarrie, Viva Books.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Understand basic concepts of quantum chemistry

CO2 Describe of wave functions and solution of Schrodinger equation for some models

CO3 Apply the approximate methods for solving multi-electron problem

CO4 Explain theories of reaction rates along with chain reactions

CO5 Acquaint with dynamics of unimolecular reactions along with the techniques for study of fast reactions

CO6 Understand the basic concepts of adsorption and equation related to it

M.Sc. Chemistry

2nd Semester

Group Theory & Spectroscopy

Course code: ACL-524

60 Hrs (4Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 3 Hrs **Total Marks: 100**

Note: *The examiner is requested to set nine questions in all, selecting two questions from each unit and one compulsory question (Question No.1 based on entire syllabus will consist of seven short answer type questions each of two marks). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Objectives: This paper deals with the basic concepts of group theory and physical aspects of molecular spectroscopy

Unit – I **15 Hrs**

Symmetry and Group Theory in Chemistry

Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Symmetry elements and symmetry operation, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation forthe C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly).

Unit – II **15 Hrs**

Character of a representation, determination of point groups of molecules, reducible and irreducible representations, rules for finding out irreducible representations, direct product. TheGreat Orthogonality theorem (without proof) and its importance. Derivation of character tablesof C2 v, C3 v and D2 h Character tables and their use.

Unit – III **15 Hrs**

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 andelectronic energy levels.

Microwave Spectroscopy

The rotation of molecules, rotational spectra of rigid diatomic molecules, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor. nuclear and electron spin interaction.

Unit – IV **15 Hrs**

Vibrational Spectroscopy

Infrared Spectroscopy: Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero-point energy, force constant and bond strengths; 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 qualitative group frequencies, overtones, hot bonds, factor affecting the band positions and intensities NCA.

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.

Books Suggested:

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L. Ho, WileyInterscience.
3. Chemical Applications of Group Theory, F.A. Cotton, Wiley.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Basic Principles of Spectroscopy, G.M. Barrow, McGraw Hill.
6. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
7. Fundamentals of molecular spectroscopy, C.N. Banwell, Tata Macgraw Hill.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Understand basic knowledge of symmetry and group theory in Chemistry

CO2 Assign the point groups to the molecules

CO3 Create the character table of various point groups and their application

CO4 Explain the interaction of electromagnetic radiation with matter

CO5 Describe the rotational and vibrational motions in molecules

CO6 Acquaint with basic principles of the Raman spectroscopy and its applications

M.Sc. Chemistry

1st & 2nd Semester

Inorganic Chemistry

Practical -I

Course code: ACP-501

240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Exam Time: 8 Hrs (two sessions of 4hrs each) **Total Marks: 200**

I Water Analysis

1. Determination of dissolved oxygen in a water sample.
2. Determination of chemical oxygen demand of a waste water sample.
3. Determination of the amount of bleaching powder required to disinfect a water sample byHorrock's test.
4. Determination of total chlorine residuals.
5. Determination of free and combined chlorine residuals.
6. To determine the minimum dose of a coagulant required to coagulate a given sample by Jar test and to compare the effectiveness of aluminium sulphate and ferric sulphate as coagulants for agiven sample at room temperature.
7. Determination of total suspended solids dried at 103-105□C
8. Determination of total dissolved solids dried at 180□C
9. Determination of fixed and volatile solids.
10. Determination of chloride content of a water sample by Mohr's Method.

II Qualitative Analysis

Ten unknown mixtures will be given containing four radicals out of which one must be aninsoluble and one may be an acid radical and two metal ions.

(a) Less common metal ions – Tl, Mo, W, Ti, Zr, Th, V, U (two metal ions in cationic/anionic forms)

(b) Insoluble– oxides (Al_2O_3, Cr_2O_3, SnO_2, TiO_2, SiO_2), sulphates ($PbSO_4$, $BaSO_4$), halides(AgCl, AgBr, AgI).

(c) Acid radicals CO_3^{2-}, HCO_3^-, SO_3^{2-}, SO_4^{2-}, CH_3COO^-, S^{2-}, PO_4^{3-}, NO_3^-, NO_2^-, Cl, Br^-, I^-, C_2O^{2-} etc.

III Preparations

Preparation of the following compounds and their spectroscopic studies.

1. $VO(acac)_2$
2. $NH_4[Cr(NH_3)_2(CNS)_4]$
3. $Mn(acac)_3$
4. $Na_3[Co(NO_2)_6]$
5. Hg [Co (NCS) 4]
6. Potassium trioxalatoferate (III) Trihydrate.
7. Dichlorobis (hydroxylamine) Zinc (II).
8. Pentathioureadicuprous nitrate.
9. Potassium trioxalato cobaltate (III).
10. Carbonato tetra-ammine cobalt (III) nitrate.

Books Suggested:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.
3. Inorganic Synthesis, Vol. 1-12, McGraw Hill.
4. Practical Inorganic Chemistry, Marr and Rocket.
5. Applied Chemistry by O.P. Virmani and A.K. Narula, New Age International.
6. Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, revised, G. Svehla, Longman.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Perform water analysis experiment for the determination of solids, dissolved oxygen, COD, chloride content, chlorine residuals etc.

CO2 Prepare various coordination complexes.

CO3 Perform experiments and evaluate the results.

CO4 Detect less common metal ions, insoluble salts and acidic radicals in mixture.

CO5 Prepare various coordination complexes.

CO6 Perform analysis and evaluate the results.

CO7 Compile interpreted information in the form of lab record.

CO8 Face/defend viva-voce examination.

M.Sc. Chemistry

1st & 2nd Semester

Organic Chemistry

Practical -I

Course code: ACP-502

240 Hrs (8Hrs /week)
Credits: 8
Exam Time: 8 Hrs (two sessions of 4hrs each)

Marks for Major Test (External): 140
Marks for Internal Exam: 60
Total Marks: 200

I Separation and Purification Techniques

Recrystallisation, Distillation: simple, fractional, steam and vacuum distillation, extraction, chromatography: thin-layer and column chromatography and Gas Chromatography.

II Qualitative Analysis

Separation and identification of organic binary solid mixtures having acidic, basic and neutral components using water, $NaHCO_3$, NaOH, HCl and ether. Preparation of suitable derivativesof isolated compounds.

III Organic Synthesis

Preparation of organic compounds Acetylation: Acetylation of cholesterol. Oxidation: Adipic acid from cyclohexanol.

Aldol condensation: Dibenzal acetone from benzaldehyde. Sandmeyer reaction: *p*-Chlorotoluene from *p*-toluidine.

Other preparations involving different types of organic reactions may be included.

Books Suggested:

1. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
2. Organic Chemistry -A Lab Mannual, D.L. Pavia, G.M..Lampman, G.S. Kriz, R.G. Engel,Cengage Learning
3. Practical Organic Chemistry, F.G. Mann, B.C. Saunders, Orient Longman
4. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller,Prentice Hall.
5. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
6. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
7. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Describe basic purification techniques in organic chemistry.

CO2 Explain basic principle and techniques of separation of binary organic mixture.

CO3 Analyse qualitatively the presence of extra elements and functional groups in the organic compound.

CO4. Separate and analyze the binary organic solid mixture using HCl and ether.

CO5 Synthesise the organic compounds by acetylation, oxidation, aldol condensation etc

CO6 Develop the skill of performing experiments, analysing data and compile experimental information in the form of lab record

M.Sc. Chemistry

1st & 2nd Semester

Physical Chemistry

Practical -I

Course code: ACP-503

240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Exam Time: 8 Hrs (two sessions of 4hrs each) **Total Marks: 200**

I Refractometry

1. Determine the refractive index of simple organic liquids like methyl acetate, ethyl acetate,methanol, ethanol, n-hexane, chloroform.
2. Determine the refractivity and molar refractivity of some organic liquids like methylacetate, ethyl acetate, methanol, ethanol, n -hexane, chloroform.
3. Determine the molar refractilities for CH_2, C, H and Cl.
4. Study the variation of refractive index with concentration for KCl solution and thereafter determine the unknown concentration of given KCl solution.

II Polarimetry

1. a) Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and thereafter determine the unknownconcentration of the same substance in given solution.
   b) Determine the specific and molecular rotation of sucrose or glucose at number ofconcentrations.
2. Study the kinetics of inversion of cane -sugar (sucrose) in presence of an acid.

III Potentiometry

1. Determine the standard electrode potential of Cu and Zn.
2. Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with $K_2Cr_2O_7$ solution.
3. Study the precipitation titration between KCl and $AgNO_3$ potentiometrically.
4. Determine the strength of iodide, bromide and chloride in a mixture by potentiometric titration with silver nitrate.

IV Conductometry

1. Determine the strength of strong acid by conductometric titration with strong base.
2. Determine the strength of weak acid by conductometric titration with strong base.
3. Determine the strength of strong acid and weak acid in a mixture by conductometric titrationwith strong base.
4. Study precipitation titration between KCl and $AgNO_3$ conductometrically. Determine thestrength of given solution of $AgNO_3$.
5. Determine the basicity of mono-, di- and tri-basic acids conductometrically.

6. Determine solubility and solubility product of sparingly soluble salts like $PbSO_4$, $BaSO_4$.

V pH-metry

1. Determine the strength of strong acid by pH-metric titration with strong base.
2. Determine the strength of weak acid by pH-metric titration with strong base.
3. Determine the dissociation constant of acetic acid using pH-meter.

VI Chemical Kinetics

1. Study the hydrolysis of methyl acetate in presence of hydrochloric acid.
2. Study saponification of ethyl acetate by sodium hydroxide solution using same initial concentration of both the reactants.
3. Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different.

VII Viscosity

1. Determine the viscosity of methyl acetate and ethyl acetate using Ostwald viscometer.
2. Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution ofglycerol.
3. Determination of molar mass of a polymer.

VIII Distribution Law

1. Determine distribution coefficient of ammonia between chloroform and water.
2. Determine the formula of the complex formed between copper (II) ion and ammonia usingdistribution method.

IX Adsorption

1. Verify the Freundlich and Langmuir adsorption isotherms for adsorption of aceticacid/oxalic acid on activated charcoal.

Books Suggested

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Pa lit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Da s and B. Behera, Tata McGraw Hill.
5. Experiments in Physical Chemistry, D.P. Shoemaker
6. Experiments in Physical Chemistry, D.V. Jahagirdhar.
7. Senior Practical Physical Chemistry by B.D. Khosla, V. Garg and A. Gulati.
8. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.

Course outcomes:

At the end of the course, the students would be able to:

CO1 Determine partition coefficients, adsorption and viscosity

CO2 Explain ion-ion interactions.

CO3 Use instruments like conductometer, pH-meter and viscometer etc.

CO4 Know the basics of kinetics of chemical reactions and determine the rates of reactions.

CO5 Determine the optical activity of the substances using polarimeter

CO6 Measure the conductance of electrolytes and application of Kohlrausch's law

CO7 Set up reference electrodes.

CO8 Evaluate dissociation behavior of electrolytes.

CO9 Verify Lambert-Beer's law.

CO10 Determine rate constant and activation energy of a chemical reaction