GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

Name of Programme: **M. Sc. Chemistry (for Affiliated Degree Colleges)**
Duration of Programme: **Two Years (Four Semesters); Choice Based Credit System (CBCS)**

SCHEME OF EXAMINATION (w.e.f. 2021)

FIRST SEMESTER								
Sr. No	**Course Code**	**Course Type**	**Course Name**	**Hrs/week L - P**	**Credits**	**Marks**		
						Ext.	**Int.**	**Total**
1.	ACL-511	Core	Inorganic Chemistry - I	4 - 0	4	70	30	100
2.	ACL-512	Core	Organic Chemistry - I	4 - 0	4	70	30	100
3.	ACL -513	Core	Physical Chemistry-I	4 - 0	4	70	30	100
4.	ACL -514 (a) or ACL -514 (b)	*Foundation Elective	Mathematics for Chemists or Chemistry of Life Science	2 - 0	2	35	15	50
5.	ACP-501	Core	Inorganic Chemistry Practical - I	0 – 8*	Annual Examination (Course spread over in semester I & II)			
6.	ACP-502	Core	Organic Chemistry Practical - I	0 – 8*				
7.	ACP-503	Core	Physical Chemistry Practical - I	0 – 8*				
			Total Credits		**14**			**350**

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

SECOND SEMESTER								
Sr. No	**Course Code**	**Course Type**	**Course Name**	**Hrs/week L - P**	**Credits**	**Marks**		
						Ext.	**Int.**	**Total**
1.	ACL-521	Core	Inorganic Chemistry - II	4 - 0	4	70	30	100
2.	ACL-522	Core	Organic Chemistry - II	4 - 0	4	70	30	100
3.	ACL -523	Core	Physical Chemistry-II	4 - 0	4	70	30	100
4.	ACL -524	Core	Group theory and Spectroscopy	4 - 0	4	70	30	100
5.	ACP-501	Core	Inorganic Chemistry Practical - I	0 – 8*	8	140	60	200
6.	ACP-502	Core	Organic Chemistry Practical - I	0 – 8*	8	140	60	200
7.	ACP-503	Core	Physical Chemistry Practical - I	0 – 8*	8	140	60	200
			Total Credits		**40**			**1000**

Note:

***For ACP-501, ACP-502, ACP-503, the total credit will be 8 each and the credit of the first semester will be cumulated in second semester as the examination is annual.**

THIRD SEMESTER								
Sr. No	**Course Code**	**Course Type**	**Course Name**	**Hrs/week L - P**	**Credits**	**Marks**		
						Ext.	**Int.**	**Total**
1.	ACL-531	Core	Organic Spectroscopy	4 - 0	4	70	30	100
2.	ACL-532 -IC or ACL-532 – OC or ACL-532 - PC	Discipline Elective	Inorganic Chemistry – III or Organic Chemistry – III or Physical Chemistry - III	4 - 0	4	70	30	100
3.	ACL-533 -IC or ACL-533 – OC or ACL-533 - PC	Discipline Elective	Inorganic Chemistry – IV or Organic Chemistry – IV or Physical Chemistry - IV	4 - 0	4	70	30	100
4.	ACL -534	Skill Enhancement	Environmental Chemistry	4 - 0	4	70	30	100
5.	ACP-504 -IC or ACP-504 – OC or ACP-504 - PC	Discipline Elective	Inorganic Chemistry Practical– II or Organic Chemistry Practical – II or Physical Chemistry Practical - II	0 – 8*	Annual*Examination (Course spread over in semester III & IV)			
6.	ACP-505 -IC or ACP-505 – OC or ACP-505 - PC	Discipline Elective	Inorganic Chemistry Practical – III or Organic Chemistry Practical – III or Physical Chemistry Practical - III	0 – 8*				
7.	ACS-501	Foundation elective	Seminar	0-1	1	50		50
			Total Credits		**17**			**450**

FOURTH SEMESTER								
Sr. No	**Course Code**	**Course Type**	**Course Name**	**Hrs/week L - P**	**Credits**	**Marks**		
						Ext.	**Int.**	**Total**
1.	ACL-541	Core	Instrumental Methods of Analysis	4 - 0	4	70	30	100
2.	ACL-542	Core	Polymer Chemistry	2 - 0	2	35	15	50
3.	ACL-543	Fundamental Elective	Chemistry and Society	2 - 0	2	35	15	50
4.	ACL-544 -IC or ACL-544 – OC or ACL-544 - PC	Discipline Elective	Inorganic Chemistry – V or Organic Chemistry – V or Physical Chemistry - V	4 - 0	4	70	30	100
5.	ACL-545 -IC or ACL-545– OC or ACL-545 - PC	Discipline Elective	Inorganic Chemistry – VI or Organic Chemistry – VI or Physical Chemistry - VI	4 - 0	4	70	30	100
6.	ACP-504 -IC or ACP-504 – OC or ACP-504 - PC	Discipline Elective	Inorganic Chemistry Practical– II or Organic Chemistry Practical – II or Physical Chemistry Practical - II	0 - 8	8*	140	60	200
7.	ACP-505 -IC or ACP-505 – OC or ACP-505 - PC	Discipline Elective	Inorganic Chemistry Practical – III or Organic Chemistry Practical – III or Physical Chemistry Practical - III	0 - 8	8*	140	60	200
			Total Credits		**32**			**800**

Note:

***For ACP-504-IC/ OC/ PC and ACP-505-IC/ OC/ PC the total credit will be 8 each and the credit of the third semester will be cumulated in fourth semester as the examination is annual.**

The allotment of specialization in the third semester to the students will be on of merit-cum-choice basis. Further, the maximum number of students in one specialization will be twenty.

M.Sc. Chemistry 1st Semester
Inorganic Chemistry - I

Course code: ACL-511
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 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, thionyl chloride 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.

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 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 structure and reaction mechanism in organic chemistry.

Unit-I **15 Hrs**

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 **15 Hrs**

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 **15 Hrs**

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 **15 Hrs**

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 S_Ni 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 the reactivity.

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.

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 **15 Hrs**

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-Brattain Space 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.

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 Algebra

Vectors

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 the solution.

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 differential calculus 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.

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-composition and 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.

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 exchange coupling 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 ligand bond 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.

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 allyl systems.

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.

M.Sc. Chemistry 2nd Semester
Physical 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 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 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-point energy, 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 dissociative adsorption, 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.

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 for the 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. The Great Orthogonality theorem (without proof) and its importance. Derivation of character tables of C_{2v}, C_{3v} and D_{2h} 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 and electronic 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, Wiley Interscience.
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.

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 by Horrock'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 a given 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 an insoluble 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^-, $C_2O_4^{2-}$ 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.

M.Sc. Chemistry 1st & 2nd Semester
Organic Chemistry Practical -I

Course code: ACP-502
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 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 derivatives of 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.

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 methyl acetate, 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 unknown concentration of the same substance in given solution.
(b) Determine the specific and molecular rotation of sucrose or glucose at number of concentrations.
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 titration with strong base.
4. Study precipitation titration between KCl and $AgNO_3$ conductometrically. Determine the strength 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 of glycerol.
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 using distribution method.

IX Adsorption

1. Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid/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.

M. Sc. Chemistry, Third Semester
Organic Spectroscopy

Course code: ACL-531
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 applications of different types of spectroscopy emphasizing more of structure elucidation.

Unit- I **15 Hrs**

Infrared Spectroscopy

Principle and Theory, instrumentation and sample handling, Fermi resonance, effect of hydrogen bonding and solvent effect on vibrational frequencies, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, amines and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds).

Unit- II **15 Hrs**

Nuclear Magnetic Resonance Spectroscopy

Principle, chemical shift, spin-spin interaction, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), complex spin-spin interaction between two, three, four and five nuclei (first order spectra), Stereochemistry, concept of topicity, effect of enantiomeric and diastereomeric protons, hindered rotation , Karplus curve-variation of coupling constant with dihedral angle. Tools for simplification of complex NMR spectrum (chemical and instrumental)-Deuteration, changing solvent, trifluoroacetylation, basification and acidification, lanthanide shift reagents, increased magnetic field strength, double resonance and nuclear overhauser effect (NOE), variable temperature probe.

Unit- III **15 Hrs**

Carbon-13 NMR Spectroscopy

Introduction, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroarmatic and carbonyl carbon), coupling constants, decoupling in ^{13}C NMR and DEPT ^{13}C NMR spectra. General introduction to two-dimensional NMR spectroscopy.

Mass Spectrometry

Introduction, ion production – EI, CI, FD and FAB, factors affecting fragmentation, molecular ion peak, metastable peak, Nitrogen rule, molecular weight determination molecular formula from isotopic ratio data, isotope profile of halogen compounds, fragmentation pattern - simple cleavage, retro-Diels Alder, Hydrogen transfer rearrangement like scrambling, ortho effect, McLafferty rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.

Unit- IV **15 Hrs**

Ultraviolet and Visible Spectroscopy

Various electronic transitions, Beer-Lambert law, visible spectrum & colour, factors effecting electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds,

ultraviolet spectra of aromatic compounds, heterocyclic compounds and charge transfer complexes. Elementary ideas about phosphorescence and fluorescence.

Combined problems relating to structure elucidation by UV, IR, NMR Spectroscopy and Mass Spectrometry.

Books Suggested:

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
2. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley.
3. Application of Spectroscopy of Organic Compounds, J.R. Dyer, Prentice Hall.
4. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw-Hill.
5. Organic Chemistry, William Kemp, John Wiley.
6. Organic Spectroscopy, Jag Mohan, Narosa Publishers, New Delhi
7. Spectroscopy, G.M. Lampman, D.L. Pavia, G.S. Kriz and J.M. Vyvyan, Cengage Learning.

M. Sc. Chemistry, Third Semester
Inorganic Chemistry -III

Course code: ACL-532-IC
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 basics of bonding of transition metal compounds and catalysis.

Unit – I **15 Hrs**

Introduction

Classification, EAN rule, general characteristics of Organometallic compounds

Alkyls and Aryls of Transition Metals

Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis.

Compounds of Transition Metal-Carbon Multiple Bonds

Alkylidenes, alkylidynes, low valent carbenes and carbynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

Unit – II **15 Hrs**

Transition Metal- π-Complexes

Transition metal π-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, cyclopentadienyl (nature of bonding of ferrocene, MO description and aromatic character), arene and trienyl complexes, preparations, properties, nature of bonding and structural features.

Unit – III **15 Hrs**

Fluxional Organometallic Compounds

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

Transition Metal Compounds with Bonds to Hydrogen

Bridging hydrides, dihydrogen complexes, synthesis and reactivity of hydride complexes.

Unit - IV **15 Hrs**

Homogeneous Catalysis

Stoichiometric reactions for catalysis, Homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), water gas shift reaction, Fischer tropsch process, oxopalladation reactions.

Books Suggested:

1. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
4. Organometallics, A. Salzer, Ch. Elschenbrioch.VCH Publications.

M. Sc. Chemistry, Third Semester
Inorganic Chemistry -IV

Course Code: ACL-533-IC
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 practical aspects of chemical analysis and concepts of spectral methods.

Unit – I **15 Hrs**

Atomic Absorption Spectroscopy

General principle, instrumental set up and analytical set up, measurement of atomic absorption and emission, analytical procedures of absorption and emission spectroscopy, sensitivity, detection limits, interference, applications.

Flame Photometry

Principles of flame photometry (flame emission spectroscopy), type of instruments, experimental technique, chemical reactions in flame, ionization in flames, spectra of metals in flames and applications.

Unit – II **15 Hrs**

Molecular Fluorescence Spectroscopy

Theory of molecular fluorescence, effect of concentration on fluorescence intensity, fluorescence instruments, application of fluorescence methods.
Molecular phosphorescence spectroscopy, chemiluminescence methods.

Unit – III **15 Hrs**

Electron Spin Resonance Spectroscopy

Theory of ESR, instrumentation, ESR Spectra of DPPH, g value and factors affecting ESR lines, Hyperfine coupling, Hyperfine splitting constant, Zero field splitting and Kramer's degeneracy, applications of ESR, study of free radicals and inorganic compounds.

Nuclear Quadrupole Resonance Spectroscopy

Quadrupole nuclei, Quadrupole moments, electric field gradient, coupling constant, splittings

Unit – IV **15 Hrs**

Mossbauer Spectroscopy

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (i) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (ii) Sn^{+2} and Sn^{+4} compounds – nature M-L bond, coordination number, structure and (iii) detection of oxidation state and inequivalent MB atoms.

Books suggested:

1. Analytical Chemistry, G.D. Christian, J. Wiley.
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
3. Analytical Chemistry-Principles, J.H. Kennedy, W.B. Saunders.
4. Analytical Chemistry-Principles and Techniques, L.G. Hargis, Prentice Hall.
5. Principles of Instrumental Analysis, D.A. Skoog, J.L. Loary, W.B. Saunders.
6. Instrumental Methods of Analysis, H.H.Willard, L.L. Merrit, J.A. Dean, F.A. Settle, CBS Publishers.
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.

M. Sc. Chemistry, Third Semester
Organic Chemistry - III

Course code: ACL-532-OC
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 Section 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 Section and the compulsory Question No.1.*

Objectives: This paper deals with (i). Nomenclature, General methods of synthesis, and Chemical reactions of smaller ring systems (heterocycles) containing one/ two heteroatoms, and (ii). Basics of photochemistry, photochemistry of organic compounds containing double bond and carbonyl groups, and several important photochemical name reactions.

Unit-I **15 Hrs**

Nomenclature of heterocyclic compounds

Systematic (Hantzsch-Widman) and replacement nomenclature for monocyclic ring systems, and fused and bridgehead ring systems containing one or more heteroatom(s).

Three-membered heterocyclic compounds
General methods of synthesis and reactions including mechanism of the following three-membered heterocyclic compounds containing one heteroatom:

Aziridines, Oxiranes and Thiiranes.

Four-membered heterocyclic compounds
General methods of synthesis and reactions including mechanism of the following four-membered heterocyclic compounds containing one heteroatom:

Azetidines, Oxetanes and Thietanes.

Unit-II **15 Hrs**

Five-membered heterocyclic compounds containing two heteroatoms

Structures, comparison of basicity, general methods of synthesis and reactions including mechanism of the following five-membered heterocyclic compounds containing two heteroatoms:

Pyrazoles, Imidazoles, Oxazoles, Isoxazoles, Thiazoles and Isothiazoles.

Unit-III **15 Hrs**

Photochemical Reactions

Absorption of light by organic molecules - interaction of electromagnetic radiation with matter, excitations and excited states, fate of an excited molecule (Jablonski diagram), yields of photochemical reactions (quantum yield), transfer of excitation energy- sensitization and quenching.

Photochemistry of Alkenes
Photochemical reactions (intramolecular) of the olefinic bond – geometrical isomerization, photosensitized cyclization reactions of conjugated alkenes, and rearrangement of 1,4-dienes (Di-π-methane rearrangement), photooxidation.

Unit-IV **15 Hrs**

Photochemistry of Carbonyl Compounds

Bond cleavage, hydrogen abstraction, intramolecular photochemical reactions of carbonyl compounds – saturated, cyclic and acyclic, β,γ-unsaturated and α,β-unsaturated compounds. Cycloaddition of carbonyls to C-C multiple bonds (Paterno-Buchi reaction).

Miscellaneous Photochemical Reactions
Barton reaction, Photo-Fries rearrangement, and Hofmann-Loffler-Freytag reaction.

Books Suggested:

1. Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
2. Heterocyclic Chemistry, J.A. Joule, ELBS.
3. The chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
4. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.
5. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An Introduction to Heterocyclic Chemistry, R.M. Acheson, John Wiley.
7. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, Pergamon Press.
8. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, Wiley-Eastern
9. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill.
10. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson.
11. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.

Photochemistry of Organic Synthesis, J. D. Coyle, Royal Society of Chemistry.

M. Sc. Chemistry, Third Semester
Organic Chemistry -IV

Course code: ACL-533-OC
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 mechanism of action & applications of enzymes and study of natural products chemistry.

Unit-I **15 Hrs**

Enzymes

Introduction, compare chemical-biological catalysis, Active site of enzymes along with its key features, Coenzymes and their role in biological reactions (with suitable examples), properties of enzymes - catalytic power, specificity and regulation. classification of enzymes (suitable examples with reactions), Fischer's lock and key, Koshland's induced fit hypothesis, identification of active site by the use of inhibitors, Enzyme kinetics, reversible (along with Lineweaver Burk Plots) and irreversible inhibition.

Unit-II **15 Hrs**

Mechanism of Enzyme Action

Transition-state theory, proximity and orientation effect, acid-base catalysis, covalent catalysis. Enzymatic mechanisms for chymotrypsin, and carboxypeptidase A.

Biotechnological Applications of Enzymes

Isolation of enzymes-extraction, centrifugation and precipitation. Purification of enzymes, techniques for immobilization of enzymes, Advantages of immobilized enzymes.

Unit – III **15 Hrs**

Terpenoids and Carotenoids

Isolation and general aspects of structure determination of terpenoids, isoprene rule. Stereochemistry, synthesis and biosynthesis of the following representative molecules: Geraniol, α-terpineol, α-pinene, camphor, farnesol and β-carotene.

Steroids

Isolation and nomenclature of steroids. Structure elucidation, synthesis (Woodward) and stereochemistry of cholesterol.

Methods for the following conversions.

i) Cholesterol → Testosterone

ii) Cholesterol → Progesterone

Unit – IV **15 Hrs**

Alkaloids

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.

Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, Nicotine, Quinine and Reserpine

.

Books Suggested:

1. Understanding Enzymes, T. Palmer, Prentice Hall.
2. Enzyme Chemistry: Impact and Applications, Ed. Collin J. Suckling, Chapman and Hall.
3. Enzyme Mechanisms Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
4. Immobilized Enzymes: An Introduction and Applications in Biotechnology, M.D. Trevan, John Wiley.
5. Enzymatic Reaction Mechanisms, C. Walsh and W.H. Freeman.
6. Biochemistry: The Chemical Reactions of Living Cells, D.E. Metzler, Academic Press.
7. Bioorganic Chemistry, G. Bertini and V. Lippard, Viva Low Priced Student Edition.
8. Natural products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman.
9. Organic Chemistry, Vol. 2, I.L. Finar, ELBS.
10. Stereoselective Synthesis: A Practical Approach, M. Nogradi, VCH.
11. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers.
12. New Trends in Natural Product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.

M. Sc. Chemistry, Third Semester

Physical Chemistry - III

Course code: ACL-532-PC

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 advance Quantum Chemistry & Group Theory.

Unit – I **15 Hrs**

Quantum Chemistry-I

VB and MO theory, effective Hamiltonian, Huckel theory of conjugated system, application to ethylene, butadiene, cyclopropenyl radial, cyclobutadiene, benzene etc. introduction to Extended Huckel theory.

Unit – II **15 Hrs**

Quantum Chemistry-II

Electron density distribution in a molecule, determination of its stability, geometry and reactivity. SCF theory, Born-Oppenheimer approximation, Hartree method, Hartree Fock method, Roothan's equation, Hellmann-Feynman theorem and its applications to chemical bonding

Unit – III **15 Hrs**

Group Theory-I

Elements of Group theory, point groups, theory of representation, reducible & irreducible representations, construction of character tables, (review of Great Orthogonality theorem) cyclic groups, SALC, Projection operators, Carbocyclic systems and MO calculation using symmetry group theoretical methods for $(CH)_n$ systems, Viz, $C_3H_3^+$, C_4H_4, C_6H_6, C_8H_8.

Unit – IV **15 Hrs**

Group Theory –II

Symmetry simplification of Huckel MO method taking Hydrocarbon naphthalene, tetra methylenecyclobutane, Group theory and normal modes of vibration of polyatomic molecules, viz. H_2O, NH_3, BF_3 etc. IR and Raman activity of modes of vibration of molecules, symmetry control of electrocyclic reaction, cycloaddition reactions and sigmatropic reactions.

Books Suggested:

1. Quantum Chemistry, I.N. Levine, Prentice Hall of India.
2. Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Chemical Application of Group Theory, F.A. Cotton Interscience.
4. Methods in Molecular Orbital Theory, A.G. Turner, Prentice Hall of India.
5. Group Theory and Symmetry in Chemistry, L.H. Hall, McGraw Hill.
6. Symmetry and Spectroscopy of Molecules, K.V. Reddy, New Age International.

M. Sc. Chemistry, Third Semester

Physical Chemistry - IV

Course code: ACL-533-PC

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 concept of surface chemistry and non-equilibrium thermodynamics.

UNIT-I **15 Hrs**

Surface Chemistry-I

Adsorption: The extent of adsorption: Physisorption and Chemisorption, adsorption isotherms (Langmuir, BET, Freundlich isotherms), rates of surface processes (adsorption and desorption), mobility on surfaces, biosensor analysis. Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), surface films on liquids (Electro-kinetic phenomenon).

UNIT-II **15 Hrs**

Surface Chemistry-II

Heterogeneous catalysis: Mechanisms of heterogeneous catalysis– Langmuir-Hinshelwood mechanism, Eley-Rideal Mechanism, catalytic activity at surfaces, Catalysis in chemical industry.

General features, structure of surfactants in solution, influence of chain length and salt concentration, surfactant parameters, surface active agents, classification of surface active agents, micellisation, hydrophobic interactions, critical micellar concentration, factors affecting CMC of surfactants, CMC temperature dependence, counter ions binding to micelles, thermodynamics of micellization-phase, solublization, microemulsion, reverse micelles.

UNIT – III **15 Hrs**

Non-Equilibrium Thermodynamics-I

Introduction to non-equilibrium thermodynamics: Basic concept of entropy production and uncompensated heat and their relation to various thermodynamic functions, Entropy production in closed and open systems, entropy balance in continuous and discontinuous systems, transformation properties of fluxes and forces, coupled and uncoupled reactions and conditions, relaxation process.

UNIT – IV **15 Hrs**

Non-Equilibrium Thermodynamics-II

Transport phenomena across membranes, thermochemical effects, thermal osmosis, electro-kinetic effect, thermo-mechanical and electrical effects.

Onsager theory and reciprocal relations, Onsager's formalism of non-equilibrium thermodynamics for multicomponent diffusion-Fick's law of diffusion, conductivity of electrolyte solutions, Onsager's formalism for transport phenomenon in electrochemical systems

Books Suggested:

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Publication
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press.
4. Non-Equilibrium Thermodynamics-principles and applications, C. Kalidas and M.V. Sangaranarayanan, McMillan.
5. Chemical Kinetics, K.J. Laidler, McGraw Hill.
6. Physical Chemistry of Surfaces, A.W. Adamson, John Wiley and Sons.

M. Sc. Chemistry, Third Semester

Environmental Chemistry

Course code: ACL-534
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 basics of environmental Chemistry

UNIT-I **15 Hrs**

Hydrosphere

Hydrological cycle of water, Water pollution – inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters – dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards.

UNIT-II **15 Hrs**

Atmosphere

Chemical composition of atmosphere – particles, ions and radicals and their formation, Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S and their effect, air pollution controls and their chemistry.

UNIT-III **15 Hrs**

Toxicology

Definition of toxicology, its history, scope and literature, Dose-response relationship. Absorption, Distribution and excretion of toxic materials. Toxicity by metal ions, (like Pb, Hg, Al, Ni, As), Organic toxicants such as halogenated hydrocarbons, pesticides and solvents, Chemical carcinogens.

UNIT-IV **15 Hrs**

Analysis of Food

Importance of Food analysis, Biomolecules- Fats, Carbohydrates (structures, uses, different types), Vitamins (uses, deficiency diseases, types of vitamins). Determination of approximate composition of fat & carbohydrates.

Suggested Readings:

1. Environmental Chemistry; A. K. De, Wiley Eastern.
2. Environmental Pollution Analysis; S. M. Khopkar, Wiley Eastern.
3. Environmental Chemistry; S. K. Banerji: Prentice– Hall.
4. Instrumental methods

M. Sc. Chemistry, Third & Fourth Semester
Inorganic Chemistry Practical-II

Course code: ACP-504-IC
240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Time: 12Hrs (spread over two days, 6 hrs each day) **Total Marks: 200**

I Spectrophotometric/Colorimetric determinations

1. To determine the strength of Cu (II) using EDTA.
2. To determine the strength of Fe (III) using EDTA.
3. Titration of Fe (II) against potassium permanganate.
4. To determine the concentration of nickel in given solution.
5. To analyse the given mixture of Cu (II) and Bi (III).
6. To determine simultaneously the As(III) and Sb (III) in the given mixture.
7. To determine the concentration of chloride ion.
8. To determine the concentration of sulphate ion.

II Chromatographic separations

9. Thin- layer chromatography-separation of nickel, manganese, cobalt and zinc. Determination of R_f values.
10. Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of R_f value.
11. Paper Chromatographic separation of Ni(II),Co(II) and Zn(II) ions.
12. Paper Chromatographic separation of Ba(II),Sr(II) and Ca(II) ions.

III Flame photometric determinations

13. To determine the concentration of sodium in the given solution.
14. To determine the concentration of potassium in the given solution.
15. To determine the concentration of calcium in the given solution.
16. To determine the concentration of lithium in the given solution.
17. To determine the concentration of sodium and potassium when present together.

IV Polarography

18. Determination of iodide using Hg (II) nitrate.
19. Determination of sulphate using lead nitrate.

Books Suggested:

1. Synthesis and Characterization of Inorganic Compounds. W.L. Jolly, Prentice Hall.
2. Synthesis and Physical studies of Inorganic compounds C.F. Bell, Pergamon Press.
3. A Textbook of Quantitative Analysis. A.I. Vogel, ELBS.

M. Sc. Chemistry, Third & Fourth Semester
Inorganic Practical-III

Course code: ACP-505-IC

240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Time: 12Hrs (spread over two days, 6 hrs each day) **Total Marks: 200**

Quantitative analysis

1. Separation of Copper and Nickel and estimation of Copper volumetrically and Nickel gravimetrically.
2. Separation of Iron and Magnesium and estimation of Iron volumetrically and Magnesium gravimetrically.
3. Separation of Silver and Nickel and estimation of Silver volumetrically and Nickel gravimetrically.
4. Separation of Copper and Barium and estimation of Copper gravimetrically and Barium gravimetrically.
5. Separation of Silver and Magnesium and estimation of Silver gravimetrically and Magnesium gravimetrically.
6. To estimate the available chlorine in bleaching powder sample.
7. To determine chlorine, bromine and iodine in a given mixture.
8. Separation of Silver and Zinc and estimation of Silver volumetrically and Zinc gravimetrically.
9. Determine strength of Silver, Copper and Nickel in the given mixture solution.
10. Determine strength of Silver, Copper and Zinc in the given mixture solution.
11. To find out the strength of Copper, Zinc and Aluminium in the given mixture solution.
12. To analyse the solder and find out the % of lead and tin.
13. To estimate the strength of Iron, Nickel and Zinc in the given sample.
14. Determine strength of Copper, Nickel and Magnesium in the given mixture solution.
15. Determine strength of Copper, Nickel and Zinc in the given mixture solution.
16. Determine strength of Silver, Nickel and Zinc in the given mixture solution.
17. Determine strength of Silver, Nickel and Magnesium in the given mixture solution.
18. Determine the amount of Copper and Zinc in the given solution or Brass.
19. Determine the amount of Copper and Tin in Bronze.

Books Suggested:

1. Synthesis and Characterization of Inorganic Compounds. W.L. Jolly, Prentice Hall.
2. Synthesis and Physical studies of Inorganic compounds C.F. Bell, Pergamon Press.
3. A Textbook of Quantitative Analysis. A.I. Vogel, ELBS, London.

M. Sc. Chemistry, Third & Fourth Semester
Organic Chemistry Practical-II

Course code: ACP-504-OC
240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Time: 12Hrs (spread over two days, 6 hrs each day) **Total Marks: 200**

1. Qualitative Analysis

Separation of components of a binary (solid+solid, liquid+solid or liquid+liquid) organic mixtures using physical and chemical methods. Characterization of the separated components with the help of chemical analysis and solid derivative formation.

2. Confirmation of the structures by spectral data

Structural characterization and confirmation of the separated components of the binary mixtures using IR, NMR (^{1}H & ^{13}C) and MS spectral data (IR, NMR and MS spectra will be provided).

3. Multi-Step Synthesis of Organic Compounds

The exercises should illustrate the use of organic reagents in their protocols and ascertain the purity of products that may involve purification by chromatographic techniques.

- Benzoin — benzil — benzillic acid (Benzilic acid rearrangement)
- Acetopheneone — acetophenone oxime — acetanilide (Beckman rearrangement)
- Benzophenone — benzopinacol (Photochemical reaction)
- p-Nitrotoluene — p-nitrobenzoic acid — p-amino benzoic acid
- Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene
- Cholrobenzene — 2,4-dinitrochlorobenzene — 2,4-dinitrophenol
- Phthalic acid — phthalic anhydride – phthalimide — Anthranilic acid

Synthesis of Heterocyclic Compounds:

- Resorcinol — 4-methyl-7-hydroxycoumarin — 6 and 8- nitro-4-methyl-7-hydroxycoumarins
- Acetylacetone — 4,6-dimethyl-2-mercaptopyrimidine — 4,6-dimethyl-2-hydrazinpyrimidine — 1-(4'-6'-dimethylpyridine-2'yl) 3,5-dimethylpyrazole
- o-Cholobenzoinc acid — N-phenylanthranilic acid — acridone.
- Hydroquinone — Benzoquinone — 5-Hydroxybenzoxathiole-2-one — 5-Acetoxy benzoxathiol- 2-one

Any other multi step synthesis may be introduced as per requirement

Students must monitor the progress of reaction and purity of final product(s) for all the stages of preparation by Thin layer Chromatography.

Books Suggested:

1. Vogel's Text Book of Practical Organic Chemistry by B.S. Furness et. al., Longman Group Ltd.
2. Elementary Practical Organic Chemistry by Arthur I. Vogel Longmans, Green and Co. 1958.
3. Experiments in Organic Chemistry by Louis F. Fieser O.C. Heath and Company Boston, 1955.

4. Practical Organic Chemistry' by Mann and Saunders.
5. A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.)., Ltd. London.
6. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Ltd.
7. Laboratory Manual in Organic Chemistry by R.K. Bansal, Wiley Eastern Ltd., New Delhi
8. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.
9. A Guide to spectroscopy in Organic Chemistry by PAVY.
10. Spectrometric Identification of Organic Compounds, Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C. Morill, John Wiley and Sons, New York.
11. Organic Spectroscopy, 3rd Ed., by William Kamp. John Wiley & Sons.
12. Spectroscopic Methods in Organic Chemistry, D.H. William & Ian Fleming.
13. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
14. Macroscale and Microscale Organic Experiments, K.L. Williamson, K.M. Masters, Cengage learning.
15. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
16. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
17. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
18. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.

M.Sc. Chemistry, Third & Fourth Semester
Organic Chemistry Practical-III

Course code: ACP-505-OC
240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Time: 12 Hrs (spread over two days, 6 hrs each day) **Total Marks: 200**

I Extraction of organic compounds from natural source

I. Isolation of caffeine from tea leaves.
II. Isolation of casein from milk.
III. Isolation of lactose from milk.
IV. Isolation of piperine from black pepper.
V. Isolation of β-carotene from carrots.

II Chromatographic Technique

High Performance Liquid Chromatography for qualitative and quantitative analysis of organic compounds.

III Colorimetric determination of the following: Carbohydrates, ascorbic acid, amino acids, cholesterol, urea.

IV Pharmaceutical analysis

I. Determination of specific rotation of ibuprofen and determination of its percentage in the unknown sample.
II. Volumetric determination of ibuprofen in the given tablet.
III. Spectrophotometric determination of aspirin content in the soluble aspirin table.
IV. Spectrophotometric determination of Paracetamol in the tablet.
V. Determination of Vitamin C in given formulation.
VI. Determination of phenobarbilone in the given cough syrup.
VII. To perform I.P. monograph of tablet

V Synthesis and characterization of the pharmaceutically important drugs:

Isoniazide, Ibuprofen, Benzocaine, paracetamol, etc.

Books Suggested:

1. Experiments in Organic Chemistry, L.F. Fieser, O.C. Heath, Company.
2. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
3. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
4. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
5. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.
6. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.), Ltd. London, 1975).
7. "Systematic Qualitative Organic Analysis" by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.
8. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors.
9. "A Guide to spectroscopy in Organic Chemistry' by PAVY
10. "Spectrometric Identification of Organic Compounds", Fifth Ed., R.M. Silverstein, G.S. Bassler and T.C. Morrile, John Wiley and Sons, New York.
11. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons.
12. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming.
13. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

M. Sc. Chemistry, Third & Fourth Semester
Physical Chemistry Practical-II

Course code: ACP-504-PC

240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Time: 12Hrs (spread over two days, 6 hrs each day) **Total Marks: 200**

I Potentiometry

1. Set up a calomel electrode (saturated) and measure its potential using the quinhydrone electrode as a reference.
2. Set up the following electrodes and measure their potentials. Obtain values for their standard electrode potentials.
   (a) Zn / $ZnSO_4$ (0.1M) (b) Cu / $CuSO_4$ (0.1M)
3. Titrate ($HCl+CH_3COOH$) solution potentiometrically and determine the concentration of each component in a mixture.
4. Titrate solution of (a) KCl / KI / KBr and (b) Mixture (KCl+KI+KBr) potentiometrically. Determine the concentration of each component in a mixture. .
5. Titrate potentiometrically a solution of ferrous ions against $K_2Cr_2O_7$ carry out the titration in reverse order.
6. Titrate Phosphoric acid potentiometrically and comment on graph.
7. Determine dissociation constant of acetic acid from its titration curve.
8. Determine the solubility and solubility product of an insoluble salt AgX (X=Cl, Br, I) potentiometrically.
9. Determine the mean activity coefficient of 0.01M HCl solution.
10. Find out pH values of three buffer solution using (a) indicator (b) pH–Meter (c) Potentiometer.

II Chemical Kinetics

11. Investigate the muta rotation of Glucose catalysed by (a) an acid (b) base.
12. Investigate the inversion of cane sugar in presence of an acid.
13. Investigation of the reaction between hydrogen peroxide and hydrogen iodide.
14. Investigate the reaction between acetone and iodine.
15. Determine the order and velocity constant of the reaction between potassium persulphate and potassium iodide.
16. Study the kinetics of iodination of acetone in presence of acids.

III Refractometry

17. Refractometric determination of the composition of solutions.
18. Determination of concentration of sugar in a solution refractometrically.

Books Suggested:

1. Practical Chemistry, A.M. James and F.E. Pricherd, Longman.
2. Practical Physical Chemistry, B.P. Levitt and Findley's, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.

M. Sc. Chemistry, Third & Fourth Semester
Physical Chemistry Practical-III

Course Code: ACP-505-PC
240 Hrs (8Hrs /week) **Marks for Major Test (External): 140**
Credits: 8 **Marks for Internal Exam: 60**
Time: 12 Hrs (spread over two days, 6 hrs each day) **Total Marks: 200**

I Polarography

1. Titrate amperometrically $Pb(NO_3)_2$ (0.001M) in KNO_3 (0.1M) +gelatine(0.005%) against standard $K_2Cr_2O_7$.Repeat the experiment in reverse order too.
2. Titrate amperometrically $Pb(NO_3)_2$ (0.001M)in KNO_3 (0.1M) +gelatine(0.005%) against standard K_2SO_4.Repeat the experiment in reverse order too.

II Colorimetry /Spectroscopy

3. Study the kinetics of oxidation of isopropyl alcohol/ ethanol by potassium dichromate. Determine the order, rate constant, energy of activation and possible mechanism for the reaction.
4. Find the stoichiometry of the complex formed between a metal ion (Fe^3) and a ligand (salicylate) by Job's continuous variation method and determine the stability constant of the complex formed.
5. Find the stoichiometry of the complex formed between a metal ion (Fe^{3+}) and a ligand (thiocyanate) by Job's continuous variation method and determine the stability constant of the complex formed.
6. Determine the solvent cut-off wavelengths for the given solvents.
7. Study the spectra of mesityl oxide/ benzophenone in different solvents and classify the observed transitions in terms of $n\rightarrow\pi^*$ and $\pi\rightarrow\pi^*$ transitions. Discuss the shift in transitions relative to those in acetone.
8. Determine the dissociation constant of phenolphthalein spectrophotometrically.
9. Record the UV Spectrum of a given compound (acetone) in cyclohexane:
   a) Plot transmittance vs. wavelength, b) Plot absorbance vs. wavelength.
10. Assign the transitions by recording UV spectra in solvents of different polarities (H_2O, CH_3OH, $CHCl_3$, CH_3CN and 1,4-dioxane). Calculate hydrogen bond energy.
11. Record the UV spectra of Benzene, pyridine and pyrimidine in methanol. Compare and discuss the various transitions observed.
12. Record the IR spectrum of few compounds and their characterization.
13. Experiment on formation and study of adsorption isotherm by UV.
14. Experiment on formation and study of micelles.

III Computational Techniques

16. Numerical methods and their applications in chemistry: Some typical exercises-
    a) Decimal- binary conversion
    b) Titration curves and end point location.
    c) pH of weak acid
    d) Roots of cubic equations (e.g. van der Wall's equation)
    e) Least square fit including graphic
    f) Chemical kinetics
17. Use of spreadsheets and certain public domain packages in solving problems in chemistry (e.g. potentiometric titration, kinetics, regression and solving simultaneous equations).

Books Suggested:

1. Practical Chemistry, A.M. James and F.E. Pricherd, Longman.
2. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill.
5. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.

M.Sc. Chemistry, Third Semester
Seminar

Course code: ACS-501 **Total Marks: 50**
Credit: 1

All the students will submit the Topic of the Seminar (Topic should be from M.Sc. Chemistry/UGC-CSIR NET/GATE syllabus) for the seminar in the begining of 3rd semester. The constituted Committee of the Department for the evaluation of seminar will notify the schedule/dates of seminar. The student is required to present the seminar on the selected topic through power point presentation and submit the hard copy of the same to the committee.

M.Sc. Chemistry, Fourth Semester
Instrumental Techniques of Analysis

Course code: ACL-541
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 instrumental methods for characterization and analysis of materials.

Unit-I **15 Hrs**

Thermo-Analytical Methods

Theory, instrumental requirements and methodology for thermo gravimetric analysis (TG), differential thermal analysis (DTA) and differential scanning calorimeter (DSC), applications in organic, inorganic chemistry and polymers. Hyphenated techniques (TG-FTIR, TG-GC) and advantages

Unit-II **15 Hrs**

Chromatographic Methods

Classification of chromatographic methods, separation and development procedure, theoretical principles, factors influencing retention, retention and equilibrium in chromatography, separating efficiency of a column and resolution, Principle of gas chromatography, instrumentation, column and stationary phases, application and advances, Hyphenated techniques- GCMS, principle of HPLC, instrumentation and application and LCMS.

Unit-III **15 Hrs**

Diffraction Methods

Bragg condition, Miller indices, Bragg method, Debye-Scherrer method (sodium chloride crystal), indexing reflections for a cubic system using powder method. identification of unit cells from systematic absences in diffraction pattern. Structure factor and its relation to intensity and electron density, introduction to phase problem. Description of the procedure for an X-ray structure analysis (NaCl). Introduction to electron diffraction, low energy electron diffraction and neutron diffraction.

Unit-IV **15 Hrs**

Advance Methods

Principles, instrumentation and applications of scanning probe microscopy, auger, scanning electron microscopy (SEM), Energy-dispersive *X*-ray spectroscopy (EDX), scanning tunnelling microscopy (STM), transmission electron microscopy (TEM), atomic force microscopy (AFM), X-ray fluorescence spectroscopy (XRF).

Books suggested:

1. Principles of Instrumental analysis, Skoog, Holler, Niemen, Saunders college publication.
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Cengage Learning.
3. Instrumental Methods of Analysis, H.H Willard, L.L. Merrit, J.A. Dean and F.A. Settle, CBS Publishers.
4. Thermal Methods of Analysis: Principles, Application and Problems, P.J. Hains, Blackie Academic and Professional.

M.Sc. Chemistry, Fourth Semester
General Polymer Chemistry

Course code: ACL-542

30 Hrs (2Hrs /week) **Marks for Major Test (External): 35**
Credits: 2 **Marks for Internal Exam: 15**
Time: 2 Hrs **Total Marks: 50**

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 three to four short answer type questions). The candidate is required to attempt five questions in all selecting one from each unit and the compulsory Question No.1.*

Unit-I **8 Hrs**

Basics and Polymerization

Introduction, classification and nomenclature of polymers, introduction to natural polymer, polymerization: condensation, addition, radical chain-ionic, coordination-Ziegler-Natta catalytic mechanism and copolymerization. Polymerization condition and reactions: polymerization in homogenous and heterogeneous systems- bulk, solution, suspension and emulsion polymerization.

Unit -II **7 Hrs**

Molecular Weight and Structure

Polydisperson-average molecular weight concept: number and weight average; practical significance of molecular weight, measurement of molecular weights by viscometry, light scattering and osmotic pressure methods. Introduction to polymer dimension (end to end distance and radius of gyration). Glass transition temperature and its importance.

Unit -III **8 Hrs**

Synthesis, Properties and Applications of Polymers

Raw material of synthetic polymers, polyethylene, polypropylene, polystyrene, polyvinylchloride, nylon-6, phenolic and amino resins, polybutadiene rubber.

Unit-IV **7 Hrs**

Conducting Polymers

Introduction, classification, conduction mechanism, electrically and electronically conducting polymers, preparation of conducting polymer- polyacetylene, Poly(p-phenylene), factors affecting the conductivity, electrochemical polymerization, doping of conducting polymers and its significance.

Books Suggested:

1 Textbook of Polymer Science, F.W. Billmeyer (Jr), Wiley.
2 Principles of Polymer Chemistry, P. J. Flory, CornellUniversity Press.
3 Physical Chemistry of Polymers, A.Tager, Mir Publishers, Moscow.
4 Physical Chemistry of Macromolecules, Tanford
5 Polymers: Chemistry & Physics of Modern materials, J.M.G. Cowie, Blackie Academic.
6 Plastic Materials, J.A. Brydson, Butter worth Heinemann.
7 Principles of Polymerisation, G.Odian, John Willey.
8 Fundamentals of Polymer Processing, S. Middleman.
9 Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.
10 Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Otta.

M.Sc. Chemistry, Fourth Semester
Chemistry and Society

Course code: ACL-543

30 Hrs (2Hrs /week) **Marks for Major Test (External): 35**
Credits: 2 **Marks for Internal Exam: 15**
Time: 2 Hrs **Total Marks: 50**

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 three to four short answer type questions). 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 interaction of Chemistry with Society.

Unit-I

Green Chemistry-I **8Hrs**

Introduction, principle of green chemistry- atom economy, green substrate, green reagent, green solvent, green catalyst, etc., different tools for green synthesis (solid phase, microwave and ultrasound assisted), role of biocatalysts in green synthesis - enzyme catalyzed oxidation, reduction and hydrolytic reactions, synthesis involving basic principle of green chemistry - synthesis of adipic acid and catechol.

Unit-II

Green Chemistry-II **8 Hrs**

Renewable energy resources: Wind energy, biomass, solar power, fuel cell; chemical from renewable feedstocks and fatty acid, polymer from renewable resources, some other chemicals from natural resource. Waste management: production, problem and prevention- Introduction, source of waste from chemical industry, waste minimization techniques, onsite waste treatment, design for degradation of DDT & surfactant, polymer recycling.

Unit -III **7 Hrs**

Introduction to industry products in daily use- perfumes, deodorants, skin care creams, hair colours and tooth pastes.

Brief introduction to IPR, need for patenting, conditions for invention to be patentable.

Weapons of mass destruction - Introduction, disarmament and peace.

Unit-IV

Application of supermolecules **7 Hrs**

Introduction, types of supramolecular interactions, host-guest chemistry, solvation and hydrophobic effect. Application of supermolecules - Molecular devices, molecular electronic and photonic devices, molecular computers and molecular machines.

Books Suggested:

1. Green Chemistry: An introduction text, M Lancaster, RSC
2. Green Chemistry and Catalysis, R. A. Sheldon, I. Arends and V. Hanefield, Wiley-VCH.
3. New Trends in Green Chemistry, V. K. Ahluwalia and M. Kidwai, Kluwer Academic Publishers and Anamaya Publishers
4. IPR Handbook for Pharma Students and Researchers, P. Dixit, Pharma Med Press.
5. Supramolecular Chemistry-Fundamental and application, K. Ariga and T. Kunitake, Springer.
6. Supramolecular Chemistry, J. W. Steed and J. L. Atwood, Wiley

M.Sc. Chemistry, Fourth Semester
Inorganic Chemistry-V

Course code: ACL-544-IC

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 bioinorganic chemistry and role of metal ions in biological systems.

Unit – I **15 Hrs**

Metal Ions in Biological Systems

Essential and trace metals. Role of metals ions in biological processes, Na^+/K^+ Pump.

Bioenergetics and ATP Cycle

DNA polymerisation, glucose storage, metal complexes in transmission of energy. Model systems.

Metal Complexes in transmission of energy

Chlophylls, Photosystem-1, Photosystem-II in Cleavage of water.

Unit - II **15 Hrs**

Transport and Storage of Dioxygen

Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin, synthetic models.

Electron Transfer in Biology

Structure and function of metalloproteins in electron transport processes – cytochromes and ion-sulphur proteins, synthetic models.

Unit - III **15 Hrs**

Metal Storage Transport and Biomineralization

Ferritin, transferrine and siderophores.

Nitrogenase

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

Unit – IV **15 Hrs**

Mettaloenzymes

Zinc enzymes- carboxypeptidase and carbonic anhydrase. Iron enzymes- catalase, peroxidase, Copper enzymes- superoxide dismutase. Molybednum oxatransferase enzymes- xanthine oxidase. Coenzyme vitamin B_{12}.

Books Suggested:

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentne, University Science Books.
3. Bio-inorganic Chemistry, R.W. Hay; Ellis Harwood limited.
4. Metal ions in Biochemistry, P.K. Blattachary, Narosa Publishing House.

M.Sc. Chemistry, Fourth Semester
Inorganic Chemistry-VI

Course code: ACL-545-IC

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 inorganic polymers and materials.

Unit - I **15 Hrs**

Introduction

Classification of Inorganic Polymers, Degree of polymerization, Determination of molecular weight

Polyphosphazenes

Synthesis route and bonding features, ring opening mechanism for polyphosphazenes, Preparation of organo/ organometallic substituted phosphazenes and their applications.

Unit – II **15 Hrs**

Polysilanes

Preparation and characterization of polysilanes, sigma bond delocalization in polysilanes & its implications, applications of polysilanes.

Polysiloxanes

Method of synthesis by anionic and cationic polymerization properties & environmental aspects, structural flexibility, analysis and testing of polysiloxanes, industrial & medical application of Polysiloxanes.

Unit – III **15 Hrs**

Co-ordination polymers

Classification, Synthesis and Applications

Fibres

Carbon, boron, glass fibre synthesis, structural behavior and applications.

Nanomaterials

Nanocrystalline phase, special properties and applications

Unit – IV **15 Hrs**

Polymeric Materials

Molecular shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behavior, polymer types and their applications, conducting and ferro-electric polymers.

Ionic Conductors

Types of ionic conductors, mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, superionic conductors, examples and applications of ionic conductors.

Books Suggested:

1. Inorganic Polymer, J.E. Mark.
2. Material Science and Engineering, An Introduction, W.D. Callister, Wiley.
3. Material Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
4. Polymer Characterization, B.J. Hunt and James I. Mark.
5. Introduction to Macromolecular Science- Peter Munk.
6. Introduction to Polymer Science, R.J. Young and P.A. Lovell.
7. Polymer Synthesis (Vol. I-III), Starley R. Somdler and Wolfkaro.
8. Polymer Science and Technology, J.R. Fried, Prentice, Hall of India.
9. Principles of Polymer Chemistry, A. Ravve, Kluwer Academic Plenum Publishers.

M.Sc. Chemistry, Fourth Semester
Organic Chemistry-V

Course code: ACL-544-OC

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 synthesis using different reagents, name reactions and disconnection approach.

Unit - I **15 Hrs**

Reagents in Organic Synthesis

Preparations, properties and applications of the following in organic synthesis with mechanistic details – lithium diisopropylamide (LDA) dicyclohexylcarbodimide (DCC), 1,3-Dithiane (reactivity umpoloung), trimethylisilyl iodide, Wilkinson's catalyst, Gilman's reagent- Lithium dimethylcuprate. Woodward and Prevost hydroxylation, DDQ, Oxidation with iodobenzene diacetate and thallium nitrate.

Unit - II **15 Hrs**

Reactions and Rearrangements

Detailed study of the following reaction- Favorskii, Arndt-Eistert synthesis, Bamberger rearrangement, Shapiro reaction, Chichibabin reaction. Mitsunobu reaction, Suzuki reaction, Buchwald-Hartwing reaction (cross-coupling), Sonogarshira reaction, Heck reaction.

Unit-III **15 Hrs**

Disconnection Approach

An introduction to disconnection approach, synthons and functional group inter-conversions, role of the order of events in organic synthesis (Guidelines with suitable examples), one group C-X disconnections and two-group C-X disconnections, Chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis.

Protecting Groups

Methods of protection of alcohol, amine, carbonyl and carboxyl groups with examples. Importance of protecting groups in organic synthesis

Unit-IV **15 Hrs**

One Group C-C Disconnections

Alcohols and carbonyl compounds, Regioselectivity (with examples). Alkene synthesis including Wittig reaction, use of acetylenes and aliphatic nitro compounds in synthesis of organic compounds.

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, Control in Carbonyl condensations 1.5-difunctionalised compounds. Michael addition and Robinson annelation.

Books Suggested:

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Foundation Books.

3. March's Advanced Organic Chemistry-Reactions, Mechanisms and Structure, M.B. Smith and Jerry March, Wiley-Interscience.
4. Advanced Organic Chemistry Part B, F.A. Carey and R.J. Sundberg, Springer.
5. Designing Organic Synthesis, S. Warren, Wiley.
6. Organic Synthesis- Concept, Methods and Starting Materials, J. Fhrhop and G. Penzillin, Verlage VCH.
7. New Horizons in Organic Synthesis, Nair V, New Age International.
8. Reagents in Organic Synthesis, Fieser and Fieser, Wiley.
9. Organic Synthesis through disconnection approach, P.S. Kalsi, Medtec.
10. Comprehensive organic transformation, R.C. Larcock, Wiley-VCH.
11. Organic Chemistry, J.G. Smith, McGraw-Hill.

M.Sc. Chemistry, Fourth Semester
Organic Chemistry -VI

Course code: ACL-545-OC
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 Section 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 Section and the compulsory Question No.1.*

Objectives: This paper deals with the drug design and development, synthesis and medicinal uses of important drug molecules of various classes.

Section-I **15 Hrs**

Drug Design and Development

Introduction to drug design and development, development of chemotherapeutic agents, therapeutic index, LD50 and ED50. Theories of drug action, concept of drugs receptor and elementary behavior of drug receptor interactions, agonists and antagonists, ion channels and their control.

Drug development: concept of lead compounds, structure-activity relationships (SAR), synthetic analogues, isosteres and bioisosteres. Quantitative structure-activity relationships (QSAR), Hansch equation. A brief overview of pharmacokinetics and pharmacodynamics, prodrug and synergism.

Section-II **15 Hrs**

Analgesics, Antipyretics and Anti-inflammatory agents

Introduction, synthesis and pharmacological uses of following drugs:

Morphine and related compounds (codeine and heroin), meperidine, methadone, aspirin, acetaminophen, indomethacin, phenylbutazone, mefenamic acid, ibuprofen and diclofenac.

Cardiovascular Drugs

Introduction, calcium channel blockers and β-blockers. Synthesis and pharmacological applications of the following cardiovascular drugs:

Nitroglycerine, isosorbide dinitrate (sorbitrate), atenolol, diltiazem and verapamil.

Antifertility agents

Introduction, ovulation inhibitors and related hormonal contraceptives- norethindrone, norethynodrel, Estradiol, mestranol; non-hormonal contraceptive- centchroman (synthesis of all the drugs excluded).

Section-III **15 Hrs**

Antibiotics

Introduction, cell wall biosynthesis and protein synthesis inhibitors. Penicillins: Synthesis and uses of the penicillin G, problems of sensitivity to acids, β-lactamases and narrow spectrum of activity solved by leading to the development of oxacillin, cloxacillin, ampicillin and amoxicillin. Synthesis and uses of cephalosporin-C. Introduction to azithromycin, tetracyclines and streptomycin (structures and pharmacological uses only).

Antineoplastic Agents

Introduction, role of alkylating agents and antimetabolites in treatment of cancer. Synthesis and medicinal uses of the following antineoplastic agents:

Mechlorethamine, cyclophosphamide, melphalan, carmustin, 5-fluorouracil and 6-mercaptopurine. Introduction to paclitaxel (synthesis of paclitaxel excluded).

Section-IV **15 Hrs**

Antimalarials

Introduction, synthesis and pharmacological applications of the following antimalarial drugs: Chloroquine, primaquine and chloroguanide.

Antimycobacterial Drugs

Introduction, synthesis and pharmacological applications of the following antimycobacterial drugs:

Isoniazid, ethambutol and dapsone.

Antimicrobial Drugs

Introduction, antibacterial and antifungal agents, Synthesis and pharmacological applications of the

following antimicrobial drugs:

Ciprofloxacin and fluconazole.

Anxiolytics (Tranquilizers)

Introduction, synthesis and pharmacological applications of the following drugs:

Diazepam, alprazolam and buspirone.

AIDS and drugs against HIV

Introduction, HIV infection to the system, nucleoside reverse transcriptase inhibitors. Synthesis and uses of AZT. Structure only and pharmacological applications of the following important drugs against HIV - ddI, ddC, d4T and 3TC.

Books Suggested:

1. An Introduction to Medicinal Chemistry, G.L. Patrick, Oxford University Press.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry,J.N. Delgado and W.A. Remers, Lippincott-Raven.
3. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
4. An Introduction to Drug Design, S.S. Pandeya and J.R. Dmmock, New Age International.
5. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1, Ed. M E Wolff, John Wiley.
6. Textbook of Medicinal Chemistry Vol. I & II, V. Alagarsamy, Elsevier
7. Synthesis of Essential Drugs, R.S. Vardanyan and V.J. Hruby, Elsevier

M. Sc. Chemistry Fourth Semester
Physical Chemistry-V

Course code: ACL-544-PC
60 Hrs (4Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Total Marks: 100

Time: 3 Hrs

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 concepts of solid state and biophysical chemistry.

Unit – I **15 Hrs**

Solid State Reaction

General principles, experimental procedures, co-precipitation as a precursor to solid-state reactions, kinetics of solid-state reactions.

Crystal Defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects– point defects, line and plane defects, vacancies-Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry defects.

Unit – II **15 Hrs**

Band Theory of Solids

Metals, insulators and semiconductors, electronic structure of solids-band theory, bank structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors.

Optical properties– Optical reflectance, photoconduction-photoelectric effects.

Magnetic Properties– Classification of materials: Quantum theory of paramagnestics-cooperative phenomena-magnetic domains, hysteresius.

Organic Solids

Electrically conducting solids, organic charge transfer complex, organic metals and new superconductors.

Unit – III **15 Hrs**

Bio-Physical Chemistry-I

Biological Cell and its Constituents: Biological cell, structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coil transition.

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

Statistical Mechanics in Biopolymers: Chain configuration of macromolecules, statistical distribution end-to-end dimensions, calculation of average dimensions for various chain structures. Polypeptide and protein structures, introduction to protein folding problem.

Biopolymer Interactions: Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibrium and various types of binding processes in biological systems. Hydrogen ion titration curves.

Unit – IV **15 Hrs**

Bio-Physical Chemistry-II

Thermodynamics of Biopolymer Solutions: Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical nerve conduction.

Cell Membrane and Transport of Ions: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamics treatment of membrane transport. Nerve conduction.

Biopolymers and their Molecular Weights: Molecular weight- Sedimentation equilibrium, hydrodynamic methods, diffusion, sedimentation velocity, electrophoresis and rotational motions.

Books Suggested:

1. Solid State Chemistry and its Applications, A.R. West Plenum.
2. Principles of the Solids State, H.V. Keer, Wiley Eastern.
3. Solid State Chemistry, N.B. Hannay.
4. Solid State Chemistry, D.K. Chakrabarty, New Age International
5. Biochemistry, L. Stryer, W.H. Freeman.
6. Biochemistry, J. David Rawn, Neil Patterson.
7. Biochemistry, Voet and Voet, John Wiley.
8. Lehninger Principles of Biochemistry, M.M. Cox and D.L. Nelson, Freeman and Company.
9. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, H. Dugas and C. Penny, Springer-Verlag.

M.Sc. Chemistry Fourth Semester
Physical Chemistry-VI

Course code: ACL-545- PC
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 kinetics of polymerization, dimensions, state and physical properties of polymers.

Unit – I **15 Hrs**

Kinetics of Polymerization

Introduction, Kinetics and statistics of step growth (condensation) polymerization, polyfunctional step-reaction polymerization, kinetics of radical chain (addition) polymerization, effect of temperature and pressure on chain polymerization, kinetics of ionic and coordination (addition) polymerization, kinetics of copolymerization.

Unit – II **15 Hrs**

Polymer Dimensions & Solutions

Average chain dimensions, freely jointed chain model, statistical distribution of end to end dimensions, chain stiffness, short range effects.

Polymer in solutions: thermodynamics of polymer solution, non ideal solutions, Flory-Huggins theory, enthalpy change of mixing and free energy change of mixing, phase equilibria, fractionation, Flory-Krigbaum theory, theta temperature, lower and upper critical solution temperatures.

Unit – III **15 Hrs**

Polymer Stereochemistry

Introduction, orientation, configuration, geometric isomerism, conformation of stereoregular polymers, factors affecting stereo regulation, homogenous stereoselective and stereospecific cationic and anionic polymerizations.

Polymer State, Structure and Properties

Crystalline state: introduction, mechanism of crystallization, temperature and growth rate, melting, thermodynamic parameters, crystalline arrangement of polymers, morphology, kinetics of crystallization

Amorphous state: molecular motion, viscoelastic behaviour, effect of chain length, rubbry state and elastomeric state; glassy state, glass transition temperature (T_g), determination and factors affecting it, free volume theory, dependence of T_g on molar mass, relaxation process in glassy state.

.

Unit – IV **15 Hrs**

Mechanical Properties

Mechanical Properties: viscoelastic state, mechanical properties, mechanical models describing viscoelasticity, linear viscoelastic behavior of amorphous polymers (creep, stress-strain and temperature effect), dynamic mechanical and dielectric thermal analysis (DMTA and DETA).

Elastomeric state

Introduction, thermodynamic aspects of rubber-like elasticity

Flow Properties of Polymer Melts

Terminology; effects on temperature, pressure and molecular weight on viscous flow properties, elastic effects in polymer melts.

Books Suggested:

1 Textbook of Polymer Science, F.W. Billmeyer (Jr), Wiley.
2 Principles of Polymer Chemistry, P J Flory, Cornell University Press.

3 Physical Chemistry of Polymers, A Tager, Mir Publishers, Moscow.
4 Physical Chemistry of Macromolecules, Tanford
5 Polymers: Chemistry & Physics of Modern materials, J.M.G. Cowie, Blackie Academic and Professional.
6 Plastic Materials, J.A. Brydson, Butter worth Heinemann.
7 Principles of Polymerisation, G.Odian, John Willey.
8 Fundamentals of Polymer Processing, S. Middleman..
9 Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.
10 Functional Monomers and Polymers, K. Takemoto, Y. Inaki and R.M. Otta