DEPARTMENT OF CHEMISTRY
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

SYLLABUS (w.e.f. 2016-2017)

Name of Programme: **M. Sc. Chemistry**
Duration of Programme: **Two Years (Four Semesters); Choice Based Credit System (CBCS)**
Credits requirement for completion of the Programme: **100 Credits**

Sr. No	Type of Course	First Year Credits				Second Year Credits				Total Credits
		First Semester		Second Semester		Third Semester		Fourth Semester		
		Theory	Pract.	Theory	Pract.	Theory	Pract.	Theory	Pract.	
1.	Core	12	12	16	12	4	-	6	-	60
2.	Discipline Elective	-	-	-	-	8	8	8	4	30
3.	Foundation	**2**	-	-	-	-	-	2	2-Smn	06
4.	Open Elective	-	-	-	-	4		-	-	04
	Total Credits	26		28		24		22		100
								Grand Total Credits		**100**

FIRST SEMESTER					
Sr. No	**Course Code**	**Course Type**	**Course Name**	**Hrs/week L - P**	**Credits**
1.	CHL-511	Core	Bonding and Properties of Inorganic Compounds	4 - 0	4
2.	CHL-512	Core	Structure and Mechanism in Organic Chemistry-1	4 - 0	4
3.	CHL-513	Core	Thermodynamics and Electrochemistry	4 - 0	4
4.	CHL-514 (a) or CHL-514 (b)	*Foundation Elective	Mathematics for Chemists or Biology for Chemists	2 - 0	2
5.	CHP-515	Core	Inorganic Chemistry Practical - I	0 - 8	4
6.	CHP-516	Core	Organic Chemistry Practical - I	0 - 8	4
7.	CHP-517	Core	Physical Chemistry Practical - I	0 - 8	4
			Total Credits		**26**

* 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**
1.	CHL-521	Core	Transition Metal Chemistry	4 - 0	4
2.	CHL-522	Core	Structure and Mechanism in Organic Chemistry-II	4 - 0	4
3.	CHL-523	Core	Quantum Chemistry and Chemical Kinetics	4 - 0	4
4.	CHL-524	Core	Symmetry and Spectroscopy	4 - 0	4
5.	CHP-525	Core	Inorganic Chemistry Practical - II	0 - 8	4
6.	CHP-526	Core	Organic Chemistry Practical - II	0 - 8	4
7.	CHP-527	Core	Physical Chemistry Practical - II	0 - 8	4
			Total Credits		**28**

THIRD SEMESTER					
Sr. No	**Course Code**	**Course Type**	**Course Name**	**Hrs/week L - P**	**Credits**
1.	CHL-531	Core	Applications of Spectroscopy	4 - 0	4
2.	CHL-532	Discipline Elective	Theory Elective - I	4 - 0	4
3.	CHL-533	Discipline Elective	Theory Elective - II	4 - 0	4
4.	CHP-534	Discipline Elective	Practical Elective – I	0 - 8	4
5.	CHP-535	Discipline Elective	Practical Elective - II	0 - 8	4
6.	----	Open Elective	From other discipline(s)/Departments	4 - 0	4
			Total Credits		**24**

Open Elective for other Discipline(s)/Departments					
1.	CHL-536-Open	Open Elective	Introduction to Spectroscopy	4 - 0	4

FOURTH SEMESTER					
Sr. No	**Course Code**	**Course Type**	**Course Name**	**Hrs/week L - P**	**Credits**
1.	CHL-541	Core	Instrumental Methods of Analysis	4 - 0	4
2	CHL-542	Core	General Polymer Chemistry	2 - 0	2
3	CHL-543	Foundation	Chemistry and Society	2 - 0	2
4.	CHL-544	Discipline Elective	Theory Elective – III	4 - 0	4
5.	CHL-545	Discipline Elective	Theory Elective – IV	4 - 0	4
6.	CHP-546	Discipline Elective	Practical Elective-III	0 - 8	4
7.	CHS-547	Foundation	Seminar	4 - 0	2
			Total Credits		**22**

DIFFERENT SETS OF ELECTIVES (THIRD AND FOURTH SEMESTERS)

Set of Electives		THIRD SEMESTER			FOURTH SEMESTER		
	Sr. No.	Course Code	Type of Elective	Course Name	Course Code	Type of Elective	Course Name
SET- A Inorganic Chemistry (IC)	**1**	CHL-532-IC	Theory Elective – I	Organometallic Chemistry	CHL-544-IC	Theory Elective – III	Photo and Bioinorganic Chemistry
	2	CHL-533-IC/AC	Theory Elective – II	Chemical Analysis and Inorganic Spectroscopy	CHL-545-IC/AC	Theory Elective – IV	Chemistry of Materials
	3	CHP-534-IC	Practical Elective – I	Inorganic Chemistry Practical-III	CHP-546-IC	Practical Elective-III	Inorganic Chemistry Practical-V
	4	CHP-535-IC/AC	Practical Elective – II	Inorganic and Analytical Chemistry Practical-IV	CHS-547	Foundation	Seminar
SET- B Organic Chemistry (OC)	**1**	CHL-532-OC	Theory Elective – I	Heterocyclic and Photochemistry	CHL-544-OC	Theory Elective – III	Organic Synthesis
	2	CHL-533-OC/PH	Theory Elective – II	Bioorganic and Natural Products Chemistry	CHL-545-OC/PH	Theory Elective – IV	Medicinal Chemistry
	3	CHP-534-OC	Practical Elective – I	Organic Chemistry Practical-III	CHP-546-OC	Practical Elective-III	Organic Chemistry Practical-V
	4	CHP-535-OC/PH	Practical Elective – II	Organic and Pharmceutical Chemistry Practical-IV	CHS-547	Foundation	Seminar
SET- C Physical Chemistry (PC)	**1**	CHL-532-PC	Theory Elective – I	Quantum Chemistry and Group Theory	CHL-544-PC	Theory Elective – III	Solid State and Biophysical Chemistry
	2	CHL-533-PC/PO	Theory Elective – II	Surface Chemistry and Non-Equilibrium Thermodynamics	CHL-545-PC/PO	Theory Elective – IV	Physical Polymer Chemistry
	3	CHP-534-PC	Practical Elective – I	Physical Chemistry Practical-III	CHP-546-PC	Practical Elective-III	Physical Chemistry Practical-V
	4	CHP-535-PC/PO	Practical Elective – II	Physical and Polymer Chemistry Practical-IV	CHS-547	Foundation	Seminar

Set of Electives		THIRD SEMESTER			FOURTH SEMESTER		
	Sr. No.	Course Code	Type of Elective	Course Name	Course Code	Type of Elective	Course Name
SET- D Analytical Chemistry (AC)	**1**	CHL-532-AC	Theory Elective – I	Electrochemical Methods	CHL-544-AC	Theory Elective – III	Analytical Chemistry
	2	CHL-533-IC/AC	Theory Elective – II	Chemical Analysis and Inorganic Spectroscopy	CHL-545-IC/AC	Theory Elective – IV	Chemistry of Materials
	3	CHP-534-AC	Practical Elective – I	Analytical Chemistry Practical-III	CHP-546-AC	Practical Elective-III	Analytical Chemistry Practical-V
	4	CHP-535-IC/AC	Practical Elective – II	Inorganic and Analytical Chemistry Practical-IV	CHS-547	Foundation	Seminar
SET- E Pharmaceutical Chemistry (PH)	**1**	CHL-532-PH	Theory Elective – I	Pharmaceutical Chemistry-I	CHL-544-PH	Theory Elective – III	Pharmaceutical Chemistry-II
	2	CHL-533-OC/PH	Theory Elective – II	Bioorganic and Natural Products Chemistry	CHL-545-OC/PH	Theory Elective – IV	Medicinal Chemistry
	3	CHP-534-PH	Practical Elective – I	Pharmaceutical Chemistry Practical-III	CHP-546-PH	Practical Elective-III	Pharmaceutical Chemistry Practical-V
	4	CHP-535-OC/PH	Practical Elective – II	Organic and Pharmaceutical Chemistry Practical-IV	CHS-547	Foundation	Seminar
SET- F Polymer Chemistry (PO)	**1**	CHL-532-PO	Theory Elective – I	Polymer Synthesis and Processing	CHL-544-PO	Theory Elective – III	Advance Polymer Chemistry
	2	CHL-533-PC/PO	Theory Elective – II	Surface Chemistry and Non-Equilibrium Thermodynamics	CHL-545-PC/PO	Theory Elective – IV	Physical Polymer Chemistry
	3	CHP-534-PO	Practical Elective – I	Polymer Chemistry Practical-III	CHP-546-PO	Practical Elective-III	Polymer Chemistry Practical-V
	4	CHP-535-PC/PO	Practical Elective – II	Physical and Polymer Chemistry Practical-IV	CHS-547	Foundation	Seminar

EXAMINATION SCHEME (As per University general rules)

Minor Tests: 20% or 20 Marks; Exam. Hours: 1 Hr
Attendance & Co curricular Activities: 10% or 10 Marks
Major Test (External): 70% or 70 Marks; Exam. Hours: 3 Hrs
Exam. Hours for each Practical: 6 Hrs

M.Sc. Chemistry Ist Semester
Bonding and Properties of Inorganic Compounds

Course code: CHL-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 bonding and properties of Lanthanides, Actinides and Non-Transition elements.

Unit - I **15 Hrs**

Theories of Bonding in Co-ordination Complexes

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, Jahn Teller theorem, trends in ionic radii, lattice energy and heat of ligation. Structure of spinels. MOT with σ and π bonding.

Unit – II **15 Hrs**

Chemistry of Lanthanides and Actinides

Extraction and applications, colour 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 Non Transition Elements

General discussion on the properties of the non transition elements, special features of individual elements, synthesis, properties and structure of their halides and oxides, polymorphism of carbon, phosphorus and sulphur, Synthesis, properties and structure of boranes, carboranes, borazines, silicates, phosphazenes, sulphur-nitrogen compounds,oxy acids of nitrogen, phosphorus, sulphur and halogens, interhalogens, pseudohalides and noble gas compounds.

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 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 Ist Semester
Structure and Mechanism in Organic Chemistry -I

Course code: CHL-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, conjugation, 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

Optical activity and chirality, absolute configuration, the Can-Ingold-Prelog system, methods of determining configuration, molecules with more than one stereogenic center, 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. Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, 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 mechanism, types of reaction, thermodynamic and kinetic requirements for reaction, kinetic and thermodynamic control, the Hammond postulate, Curtin-Hammett principle. Potential energy diagrams, methods of determining mechanisms, Generation, structure, stability and reactivity of carbocations, carbanions free radicals, carbenes and nitrenes. Effect of structure on reactivity – resonance and field effects, steric effect. Quantitative treatments of the effect of structure on reactivity - Hammett equation and linear free energy relationship.

Unit -IV **15 Hrs**

Aliphatic Nucleophilic Substitution

The S_N2, S_N1, mixed S_N1 and S_N2 and SET Mechanisms; The neighbouring group mechanism, neighbouring group participation by σ and π bonds; Classical and 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.

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.

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 Ist Semester
Thermodynamics and Electrochemistry

Course code: CHL-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 properties- partial molar free energy, partial molar volume and partial molar heat content and their significance, determination of these quantities. Concept of fugacity and determination of fugacity.

Non-ideal systems: Excess functions for non-ideal solutions. Activity, activity coefficient, Debye-Hückel theory for activity coefficient of electrolytic solutions, determination of activity and activity coefficients, ionic strength.

Application of phase rule to three component systems; second order phase transitions.

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, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions.

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

Unit -III **15 Hrs**

Electrochemistry-I

Electrochemistry of solutions: Debye-Hückel–Onsager treatment and its extension, ion-ion interactions.

Electrified interface: Electrode/electrolyte interface, 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, capacitance of interface and surface excess.

Structure of electrified interfaces: Helmholtz-Perin, Guoy-Chapman, Stern, Graham-Devanathan-Mottwatts, Devanathan models.

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, tunnelling.

Electrocatalysis– influence of various parameters. Hydrogen electrode.

Bioelectrochemistry, threshold membrane phenomena, Nernst-Planck equation, Hodges-Huxley equations.

Polarography theory, Ilkovic equation, half wave potential and its significance.

Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and prevention methods.

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 Ist Semester
Mathematics for Chemists

Course code: CHL-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 Ist Semester
Biology for Chemists

Course code: CHL-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 for those students who were having mathematics in graduation.

Unit -I **7 Hrs**

Cell Structure and Functions

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.

Unit -II **8 Hrs**

Carbohydrates

Introduction, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars. N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides – cellulose and chitin. Storage polysaccharides – starch and glycogen. Structure and biological functions of glucosaminoglycans or mucopolysaccharides. Glycoproteins and Glycolipids. Carbohydrate metabolism - Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

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 stabalization of protein structure.

Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA), 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 Ist Semester
Inorganic Chemistry Practical - I

Course code: CHP-515
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

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 Preparations

Preparation of the following compounds:

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. $Cu_2[HgI_4]$

Books Suggested:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis, revised, G. Svehla, Longman.
3. Practical Inorganic Chemistry, Marr and Rocket.
4. Applied Chemistry by O.P. Virmani and A.K. Narula, New Age International.

M.Sc. Chemistry Ist Semester
Organic Chemistry Practical - I

Course code: CHP-516
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Separation and Purification Techniques

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

II Qualitative Analysis

Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives.

III Quantitative Analysis

Determination of the percentage or number of hydroxyl groups in organic compounds by acetylation method. Estimation of amines/phenols.

Books Suggested:

1. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
2. Macroscale and Microscale Organic Experiments, K.L. Williamson, K.M. Masters, Cengage learning.
3. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
4. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
5. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

M.Sc. Chemistry Ist Semester
Physical Chemistry Practical - I

Course code: CHP-517
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Error Analysis and Statistical Data Analysis

1. Errors, types of errors, minimization of errors, error distribution curves, precision, accuracy and combination; statistical treatment for error analysis, student 't' test, null hypothesis, rejection criteria, F& Q test; linear regression analysis, curve fitting.
   Calibration of volumetric apparatus, burette, pipette and standard flask.

II Partition Coefficient

2. To study the distribution of benzoic acid between benzene and water at room temperature and show that benzoic acid dimerizes in benzene.

III Adsorption

3. To investigate the adsorption of oxalic acid from aqueous solutions by activated charcoal and examine the validity of Langmuir's adsorption isotherm.

IV Viscosity

4. To study the variation of viscosity of a liquid with composition of the mixture of liquids.

V Conductometry

5. Determination of the equivalent conductance of strong electrolytes such as HCl, KCl, KNO_3, $AgNO_3$, and NaCl and the validity of Onsager equation.
6. Study conductometeric titration of (1) HCl / NaOH (2) CH_3COOH / NaOH and comment on nature of graph.
7. Study conductometeric titration of (1) HCl / NH_4OH (2) CH_3COOH / NH_4OH and comment on nature of graph
8. Determine the equivalent conductance, degree of dissociation and dissociation constant of acetic acid.
9. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.

VI pH– metry

10. To determine the strength of strong acid by titrating against strong base.
11. To determine the strength of strong acid by titrating against weak base.
12. To determine the strength of weak acid by titrating against strong base.

VII Colorimetry/Spectrophotometry

13. Verification of the Lambert-Beer's law using solutions such as $K_2Cr_2O_7$, $KMnO_4$, $CuSO_4$ in water, I_2 in CCl_4.

VIII Chemical Kinetics

14. Determine the rate constant of hydrolysis of an ester such methyl acetate catalyzed by an acid. Determine its energy of activation.

IX Polarimeter

15. To determine specific and molecular rotation of an optically active substance.

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 IInd Semester
Transition Metal Chemistry

Course code: CHL-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 of Transition Metal Complexes

Microstates, Spectroscopic ground states (Term symbols) and the evaluation of energies of various J states of free ions, Coupling Schemes, Term symbols for excited states, Energies of Terms, Racah Parameters, Selection rules, splitting of S, P, D and F terms under octahedral and tetrahedral electrostatic potential, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, B, β and x parameters.

Unit- II **15 Hrs**

Charge Transfer Spectra and Magnetic Properties of Transition Metal Complexes

Charge transfer spectra of complexes (both metal to ligand and ligand to metal), Magnetic moment, various types of magnetism: Diamagnetism, Pramagnetism, Ferro and Anti ferromagnetism, effect of temperature and magnetic field on various types of magnetism

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 mechnasim, factors affecting rate of outer sphere reactions, inner sphere type reactions, bridge mechanism and its consequences, evidencies 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. Wulf'sburg, University science books.
7. Introduction to ligand fields, B.N. Figgis, Wiley Eastern.

M.Sc. Chemistry IInd Semester
Structure and Mechanism in Organic Chemistry- II

Course code: CHL-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 basic concepts of structure and reaction mechanism in organic chemistry

Unit-I **15 Hrs**

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, ipso attack, Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.

Aromatic Nucleophilic Substitution

The S_N^{Ar}, S_N^1, benzyne and S_{RN}^1 mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

Aliphatic Electrophilic Substitution

Bimolecular mechanisms – S_E^2 and S_E^i. The S_E^1 mechanism, electrophilic substitution accompanied by double bound shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

Unit-II **15 Hrs**

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity in the attacking radicals. The effect of solvents on reactivity.

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

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. FMO and PMO approach for Sigmatropic rearrangements, suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3,3-and 5,5-sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Ene reaction.

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 IInd Semester
Quantum Chemistry & Chemical Kinetics

Course code: CHL-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 Chemistry-I

Introduction to Exact Quantum Mechanical Results

Hermition operators and their properties, commutation relations, postulates of quantum mechanics, uncertainty principle, Schrodinger equation and its interpretation.

Discussion of solutions of the Schrödinger equation to some model systems viz., particle in a box, simple harmonic oscillator, selection rules, expectation values, hydrogen atom and its complete solution, spherical harmonics as wave functions of rigid rotator, total wave functions of H-like atoms, shapes of atomic orbital.

Unit – II **15 Hrs**

Quantum Chemistry-II

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.

Angular Momentum

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

Electronic Structure of Atoms

Electronic configuration, Russell-Saunders terms and coupling schemes, Slater-Condon parameters, term separation energies of the p^n (n=2) configuration, term separation energies for the d^n (n=2) configurations, magnetic effects: spin-orbit coupling and Zeeman splitting, Introduction to the method of self consistent field, virial theorem.

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 isotherm, surface films on liquids (Electro-kinetic phenomenon)

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 IInd Semester
Symmetry & Spectroscopy

Course code: CHL-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 symmetry, group theory and physical aspects of molecular spectroscopy

Unit – I **15 Hrs**

Symmetry and Group Theory in Chemistry

Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schonflies 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**

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. Character tables and their use.

Unit – III **15 Hrs**

Basic Principles

Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarisation 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

Classification of molecules, rigid rotor model, 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 IInd Semester
Inorganic Chemistry Practical -II

Course code: CHP-525
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I 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) Insolubles– 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.

II Preparations

Preparation of the following compounds and their spectroscopic studies.

1. Potassium trioxalatoferate (III) Trihydrate.
2. Dichlorobis (hydroxylamine) Zinc (II).
3. Pentathioureadicuprous nitrate.
4. Potassium trioxaltochromate (III).
5. Potassium trioxalato cobaltate (III).
6. 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.

M.Sc. Chemistry IInd Semester
Organic Chemistry Practical - II

Course code: CHP-526
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Qualitative Analysis

Analysis of an organic mixture containing two solid components using HCl and ether for separation and preparation of suitable derivatives.

II Organic Synthesis

Preparation of organic compounds involving one step.
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 one/two steps may be included.

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. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
4. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
6. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

M.Sc. Chemistry IInd Semester
Physical Chemistry Practical - II

Course Code: CHP-527
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Potentiometry

1. Prepare and test the calomel electrode.
2. Titrate potentiometrically (1) HCl / NaOH (2) HCl / NH_4OH.
3. Titrate oxalic acid and sodium hydroxide potentiometrically.
4. Titrate Mohr's salt against $KMnO_4$ potentiometrically and carry out the titration in reverse order.

II Chemical Kinetics

5. Determine the velocity constant of hydrolysis of ethyl acetate using sodium hydroxide solution.

III Conductometry

6. Study conductometric titration of (1) NH_4Cl / NaOH (2) CH_3COONa / HCl and comment on nature of graph.
7. Study conductometric titration of (1) $MgSO_4$ / $Ba(OH)_2$ (2) $BaCl_2$ / K_2SO_4 and comment on nature of graph.
8. To study stepwise neutralization of polybasic acid i,e oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the graph.
9. To determine the relative strength of two acids using conductometer.

IV pH– metry

10. To determine the hydrolysis constant of aniline hydro chloride.
11. Find out the dissociation constant of weak acid.

V Colorimetry/Spectrophotometry

12. Determine the concentration of $K_2Cr_2O_7$ and $KMnO_4$ in mixture of ($K_2Cr_2O_7$ + $KMnO_4$) solution.
13. Determine the concentration of Crystal violet and Aurine in mixture of (crystal violet + aurine) solution.

VI Polarimetery

14. To determine the concentration of an optically active substance.
15. To determine the percentage of two optically active substances in a given mixture.

VII Refractrometer

16. To determine the refrective index of some liquids.
17. To determine the molar refrectivity of CH_3OH, CH_3COOH, $CH_3COOC_2H_5$ and CCl_4 and calculate the refractive equivalent of C, H and Cl atoms.
18. Find out molar refractivity of benzene, toluene, propyl alcohol, butyl alcohol etc. and $–CH_2$-group of homologous series.

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 IIIrd Semester
Applications of Spectroscopy

Course code: CHL-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**

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, fluorescence, Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD).

Unit- II **15 Hrs**

Infrared Spectroscopy

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- III **15 Hrs**

Nuclear Magnetic Resonance Spectroscopy

Introduction , 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), Karplus curve-variation of coupling constant with dihedral angle. Simplification of complex spectra- nuclear magnetic double resonance, contact shift reagents and nuclear Overhauser effect (nOe).

Unit- IV **15 Hrs**

Carbon-13 NMR Spectroscopy

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroarmatic and carbonyl carbon), coupling constants and DEPT ^{13}C NMR spectra. General introduction to two-dimensional NMR spectroscopy - COSY. HSQC, HMBC, INADEQUATE and NOESY.

Mass Spectrometry

Introduction, ion production – EI, CI, FD and FAB, factors affecting fragmentation, McLafferty rearrangement, Nitrogen rule. Mass spectral fragmentation of organic compounds, common functional groups, molecular High resolution mass spectrometry (HRMS).

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.

Elective: SET-A
Inorganic Chemistry (IC)

M.Sc. Chemistry IIIrd Semester
Organometallic Chemistry
Theory Elective - I

Course code: CHL-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**

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

Homogeneous Catalysis **15 Hrs**

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.

Elective: SET-A & SET-D
Inorganic Chemistry (IC)

M.Sc. Chemistry IIIrd Semester
Chemical Analysis and Inorganic Spectroscopy
Theory Elective - II

Course CHL-533-IC/AC
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**

Practical Aspects of Chemical Analysis

Role of analytical chemistry, classification of analytical methods-classical and instrumental, types of instrumental analysis, selecting an analytical method, volumetric glassware-cleaning and calibration of glassware, sample preparations - dissolution and decompositions, desiccators and desiccants, filteration and ignition of solids, selecting and handling of reagents and other chemicals, safety in the analytical laboratory.

Errors and Evaluation- Definition of terms - mean and median, precision, standard deviation, accuracy. Errors – systematic (determinate), random (indeterminate), gross, errors in measurement, sources of errors and the effects upon the analytical results and its minimization.

Methods for reporting analytical data, Statistical evaluation of data, uses of statistics.

Unit – II **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 – III **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 – IV **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.

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.

Elective: SET-A
Inorganic Chemistry (IC)

M.Sc. Chemistry IIIrd Semester
Inorganic Chemistry Practical-III
Practical Elective-I

Course code: CHP-534-IC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

Quantitative Analysis

1. Separation of Copper and Nickel and estimation of Copper volumetrically and Nickel gravimetrically.
2. Separation of Copper and Zinc and estimation of Copper gravimetrically and Zinc volumetrically.
3. Separation of Iron and Magnesium and estimation of Iron volumetrically and Magnesium gravimetrically.
4. Separation of Iron and Nickel and estimation of Iron gravimetrically Nickel gravimetrically.
5. Separation of Silver and Nickel and estimation of Silver volumetrically and Nickel gravimetrically.
6. Separation of Copper and Barium and estimation of Copper gravimetrically and Barium gravimetrically.
7. Separation of Silver and Magnesium and estimation of Silver gravimetrically and Magnesium gravimetrically.
8. Separation of Copper and Magnesium and estimation of Copper gravimetrically and Magnesium gravimetrically.
9. Separation of Silver and Zinc and estimation of Silver volumetrically and Zinc gravimetrically.
10. Separation of Silver and Copper and estimation of Silver gravimetrically and Copper gravimetrically.

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.

Elective: SET-A & SET-D
Inorganic Chemistry (IC)

M.Sc. Chemistry IIIrd Semester
Inorganic and Analytical Chemistry Practical-IV
Practical Elective-II

Course code: CHP-535-IC/AC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

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.

III Flame photometric determinations

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

IV Polarography

16. Determination of iodide using Hg(II) nitrate.
17. 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.

Elective: SET-B
Organic Chemistry (OC)

M.Sc. Chemistry IIIrd Semester
Heterocyclic Chemistry and Photochemistry
Theory Elective - I

Course code: CHL-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 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 methods of synthesis and reactions of heterocycles, and photochemistry of organic compounds.

Unit-I **15 Hrs**

Nomenclature of Heterocyclic Compounds

Three and Four Membered Heterocyclic Compounds

Synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes.

Unit-II **15 Hrs**

Six membered Heterocyclic Compounds

Synthesis and reactions of α-pyrones, γ-pyrones and pyrylium salts.

Fused Heterocyclic Compounds

Synthesis and reactions of benzopyrroles, benzofurans, benzothiophenes, benzopyrylium salt and quinolinizium salt.

Unit-III **15 Hrs**

Photochemical Reactions

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Photochemistry of Alkenes

Intramolecular reactions of the olefinic bond– geometrical isomerism, sensitized cyclization reactions, rearrangement of 1,4-dienes.

Unit-IV **15 Hrs**

Photochemistry of Carbonyl Compounds

Intramolecular reactions of carbonyl compounds– saturated, cyclic and acyclic, β,γ-unsaturated and α, β-unsaturated compounds. Cycloaddition to alkenes.

Miscellaneous Photochemical Reactions

Photo-Fries rearrangement, Barton reaction and Hofmann-Lofler-Freytag reaction.

Books Suggested:

1. Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
2. The chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, J.A. Joule, ELBS.
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.
12. Photochemistry of Organic Synthesis, J.D. Coyle, Royal Society of Chemistry.

Elective: SET-B & SET-E
Organic Chemistry (OC)

M.Sc. Chemistry IIIrd Semester
Bioorganic and Natural Products Chemistry
Theory Elective - II

Course code: CHL-533-OC/PH
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, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. classification of enzymes (suitable examples of reactions), Fischer's lock and key and Koshland's induced fit hypothesis, identification of active site by the use of inhibitors, affinity labeling. Enzyme kinetics, reversible 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

Extraction and purification of enzymes, methods for immobilization of enzymes, application of immobilized enzymes.

Unit – III **15 Hrs**

Terpenoids and Carotenoids

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Stereochemistry, synthesis and biosynthesis of the following representative molecules: Citral, α-Terpeneol, Farnesol, Phytol and β-carotene.

Steroids

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. isolation and synthesis of Cholesterol, Testorosterone, Progesterone Oestrone.

Unit – IV **15 Hrs**

Alkaloids

Introduction, nomenclature, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen Heterocyclic ring.

Stereochemistry, synthesis and biosynthesis of the following: Ephedrine, Nicotine, Atropine and Quinine.

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.

Elective: SET-B
Organic Chemistry (OC)

M.Sc. Chemistry IIIrd Semester
Organic Chemistry Practical – III
Practical Elective-I

Course code: CHP-534-OC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Qualitative Analysis

Characterization of organic compounds with the help of chemical analysis and confirmation of their structures by IR and PMR spectral data (IR & PMR spectra to be provided).

II Spectrophotometric (UV/VIS) Estimations of the following:

Carbohydrates, ascorbic acid, amino acids, proteins, cholesterol, urea.

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. Macroscale and Microscale Organic Experiments, K.L. Williamson, K.M. Masters, Cengage learning.
4. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
6. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
7. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.
8. Organic Spectroscopy, William Kemp. John Wiley & Sons.

Elective: SET-B & SET-E
Organic Chemistry (OC)

M.Sc. Chemistry IIIrd Semester
Organic and Pharmaceutical Chemistry Practical-IV
Practical Elective-II

Course code: CHP-535-OC/PH
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Extraction of organic compounds from natural source
Isolation of caffeine from tea leaves.
Isolation of casein from milk.
Isolation of lactose from milk.
Isolation of piperine from black pepper.
Isolation of β-carotene from carrots.

II Chromatographic Technique
High Performance Liquid Chromatography and Gas Chromatography for qualitative and quantitative analysis of organic compounds.

III Synthesis and characterization of some organic compounds of medicinal interest
Paracetamol, aspirin, phenyltoin, phenylbutazone, DEET, 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. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
6. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.

Elective: SET-C
Physical Chemistry (PC)

M.Sc. Chemistry IIIrd Semester
Quantum Chemistry & Group Theory
Theory Elective – I

Course code: CHL-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.

Elective: SET-C & SET-F
Physical Chemistry (PC)

M.Sc. Chemistry IIIrd Semester
Surface Chemistry & Non-Equilibrium Thermodynamics
Theory Elective -II

Course code: CHL-533-PC/PO
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 non-equilibrium thermodynanics, different processes at solid surfaces and energy conversion.

Unit – I **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, Onsager theory and reciprocal relations, transformation properties of fluxes and forces, coupled and uncoupled reactions and conditions, relaxation process, transport phenomena across membranes, thermochemical effects, thermal osmosis, electrokinetic effect, thermomechanical and electrical effects, phenomenological equations for energy release in biological reactions.

Unit – II **15 Hrs**

Non-Equilibrium Thermodynamics-II

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.

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.

Unit – III **15 Hrs**

Processes at Solid Surfaces

Introduction to the growth and structure of solid surfaces. 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.

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

Unit – IV **15 Hrs**

Surfactants

General features, structure of surfactants in solution, critical micellation concentration (CMC), temperature dependence, influence of chain length and salt concentration, surfactant parameters

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. Electrochemistry, S. Glasstone, Affiliated East-West Press.
7. Modern Electrochemistry, Vol.1 and II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
8. Physical Chemistry of Surfaces, A.W. Adamson, John Wiley and Sons.

Elective: SET-C
Physical Chemistry (PC)

M.Sc Chemistry IIIrd Semester
Physical Chemistry Practical - III
Practical Elective-I

Course code: CHP–534–PC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

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.

II Chemical Kinetics

7. Investigate the muta rotation of Glucose catalysed by (a) an acid (b) base.
8. Investigate the inversion of cane sugar in presence of an acid.
9. Investigation of the reaction between hydrogen peroxide and hydrogen iodide.
10. Investigate the reaction between acetone and iodine.
11. Determine the order and velocity constant of the reaction between potassium persulphate and potassium iodide.

III Refractometry

12. Refractometric determination of the composition of solutions.
13. 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.

Elective: SET-C & SET-F
Physical Chemistry (PC)

M.Sc Chemistry IIIrd Semester
Physical and Polymer Chemistry Practical - IV
Practical Elective-II

Course code: CHP–535–PC/PO
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Conductometry

1. Determine the strength of (acetic acid + hydrochloric acid) by titrating against NaOH.
2. Determine the hydrolysis constant of aniline hydrochloride.
3. Titrate a moderately strong acid (salicylic acid) by
   (a) Salt line method and (b) Double alkali method.
4. Titrate a mixture of (H_2SO_4 + CH_3COOH) against NaOH.
5. Determine of strength of (HCl + NH_4Cl) titrating against NaOH.
6. Estimate concentration of each component of a mixture of $AgNO_3$ and HNO_3 by titrating against NaOH conductometerically.

II Spectrophotometry

7. Determine of strength of Fe (II) titrating against $KMnO_4$.
8. Determine of strength of Fe (II) titrating against EDTA solution.
9. Study of absorption of picric acid on charcoal by using colorimeter.
10. Study of dissociation constant of phenolphthalein by colorimeter.

III Polarography

11. Record polarogram of a solution of KCl (0.1M) in absence and presence of 0.005% gelatin in the solution. Explain the nature of polarograms. Repeat the experiment after expelling the dissolved oxygen with a stream of nitrogen gas (5-10 mm). What do you conclude from the experiment?
12. Determine the half wave potential and diffusion current of Cd^{2+} (0.001M) + Zn^{2+} (0.001M) +KCl (0.1M) + gelatine (0.005%). Estimate the concentration of the ions in separate and mixed solutions.
13. Determine the half wave potential and diffusion current of Zn (II) ion and Cd(II) ion in (a) Cd^{2+} (0.001M) in KCl (0.1M) (b) Zn^{2+} (0.001M) in KCl (0.1M).

IV Polymer Chemistry

14. Measurement of phase transition, glass temperature, heat transitions in polymers.
15. Measurement of conductivity (thermal & electrical)/electrical and optical properties.
16. Determination of molecular weight by viscosity/any other methods.
17. Kinetics of polymerization/ polymer degradation.

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.
6. Thermal Methods of Analysis: Principles, Application and Problems, P.J. Hains, Blackie Academic and Professional.

Open Elective for other discipline(s)/departments

Introduction to Spectroscopy

Course code: CHL-536-Open
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 and important applications of different techniques of spectroscopy.

Unit- I 15 Hrs

Ultraviolet and Visible Spectroscopy

Brief review of electromagnetic spectrum and absorption of radiation, factors affecting the position of UV bands, Various electronic transitions, Beer-Lambert law, visible spectrum & colour, effect of solvent on 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 and heterocyclic compounds.

Unit- II 15 Hrs

Infrared Spectroscopy

Introduction, basic principles, Instrumentation and sample handling. Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance.

UNIT III 15 Hrs

Nuclear Magnetic Resonance Spectroscopy

General introduction and definition, chemical shift, factors affecting chemical shift, solvents, spin-spin interaction, shielding and deshielding mechanism, 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), chemical exchange, nuclear Overhauser effect (nOe).

Unit-IV 15 Hrs

Mass Spectrometry

Basic principles and instrumentation, ion production– EI, CI, FD and FAB, MALDI, factors affecting fragmentation, ion analysis, ion abundance, molecular ion peak, metastable peak, McLafferty rearrangement, Nitrogen rule. Mass spectral fragmentation of organic compounds, common functional groups.

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 Spectroscopy, William Kemp, John Wiley.
6. Organic Spectroscopy, Jag Mohan, Narosa Publishers.

M.Sc. Chemistry IVth Semester
Instrumental Methods of Analysis

Course code: CHL-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**

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-II **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-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 IVth Semester
General Polymer Chemistry

Course code: CHL-542
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 basic aspects of polymer chemistry.

Unit-I **8 Hr**

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 IVth Semester
Chemistry and Society

Course code: CHL-543
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 interaction of Chemistry with Society.

Unit-I

Green Chemistry-I **8Hrs**

Introduction, different tools for green synthesis (elementary idea of green reagent, green solvent, green catalyst, solid phase, microwave and ultrasound assisted), atom economy, 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 BHC.

Unit-II

Green Chemistry-II **8 Hrs**

Renewable energy resources: fossil fuels, 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 **7Hrs**

Introduction, nature of supramolecular interactions, host-guest chemistry, solvation and hydrophobic effect. Application of supermolecules- Molecular device, reading signal from molecular device, molecular electronic and photonic devices, molecular computers and molecular machines.

Books Suggested:

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

Elective: SET-A
Inorganic Chemistry (IC)

M.Sc. Chemistry IVth Semester
Photo and Bioinorganic Chemistry
Theory Elective - III

Course code: CHL-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 photoinorganic chemistry and role of metal ions in biological systems.

Unit – I **15 Hrs**

Photoinorganic Chemistry

Absorption, excitation, photochemical laws, quantum yield, electronically excited states-life times-measurements of the times. Flash photolysis, stopped flow techniques. Energy dissipation by radiative and non radiative processes, absorption spectra, Franck – Condon principle, photochemical stages- primary and secondary processes, Electronically excited states of metal complexes. Photosubstitution, photooxidation and photoreduction, lability and selectivity.

Unit – II **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.

Nitrogenase

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

Unit - III **15Hrs**

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 – IV **15 Hrs**

Mettaloenzymes

Zinc enzymes- carboxypeptidase and carbonic anhydrase. Iron enzymes- catalase, peroxidase and cytochrome P-450. Copper enzymes- superoxide dismutase. Molybednum oxatransferase enzymes-xanthine oxidase. Coenzyme vitamin B_{12}.

Metal Storage Transport and Biomineralization

Ferritin, transferrine and siderophores.

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.
5. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fieischauer, Wiley.
6. Photochemistry of Coordination Compounds, V Balzari and V. Carassiti, Academic Press.

Elective: SET-A & SET-D
Inorganic Chemistry (IC)

M.Sc. Chemistry IVth Semester
Chemistry of Materials
Theory Elective - IV

Course code: CHL-545-IC/AC
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**

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**

Fibres

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

Glasses, Ceramics, composites and nanomaterials

Glassy state, glass formers and glass modifiers, applications. Ceramic structures, mechanical properties, clay products. Refractories, characterizations, properties and applications.

Microscopic composites, fibre-reinforced composites. Nanocrystalline phase, special properties, applications

Unit – IV **15 Hrs**

Polymeric Materials

Molecular shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behaviour, 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.

Elective: SET-A
Inorganic Chemistry (IC)

M.Sc. Chemistry IVth Semester
Inorganic Chemistry Practical-V
Practical Elective-III

Course code: CHP-546-IC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

Quantitative analysis

Quantitative analysis of elements or groups by available analytical technique.

1. Determine the strength of silver, copper and nickel in the given mixture solution.
2. Determine the strength of silver, copper and zinc in the given solution.
3. To find out the strength of copper, zinc and aluminium in the given mixture solution.
4. To analyse the solder and find out the % of lead and tin.
5. To estimate the strength of silver, copper, nickel and zinc in silver coin.
6. To estimate the strength of iron, nickel and zinc in the given sample.
7. Determine the strength of copper, nickel and magnesium in the given mixture solution.
8. To estimate the available chlorine in bleaching powder.
9. To determine the chlorine, bromine and iodine in a given mixture.
10. To analyse the galena and find out the % of lead.
11. To find out the strength of copper, nickel and zinc in the given mixture solution.
12. To find out the strength of silver, nickel and zinc in the given mixture solution.
13. To find out the strength of silver, nickel and magnesium in the given mixture solution.
14. Determination of the amount of copper and zinc in the given solution or brass.
15. To determine the 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 compound C.F. Bell, Pergamon Press.
3 A Textbook of Quantitative Analysis. A.I. Vogel, ELBS.

Elective: SET-B
Organic Chemistry (OC)

M.Sc. Chemistry IVth Semester
Organic Synthesis
Theory Elective - III

Course code: CHL-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

Principle, 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, tri-n-butyltin hydride, Woodward and Prevost hydroxylation, DDQ, Oxidation with Ruthenium tetraoxide, iodobenzene diacetate and thallium nitrate.

Unit - II **15 Hrs**

Reactions and Rearrangements

A detailed study of the following reaction- Favorskii, Arndt-Eistert synthesis, Baeyer-Villiger, Shapiro reaction, Chichibabin reaction. Mitsunobu reaction, Suzuki reaction, Buchwald-Hartwing reaction (cross-coupling), Sonogarshira reaction.

Unit-III **15 Hrs**

Disconnection Approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X disconnections and two-group C-X disconnections, chemoselectivity, cyclisation reactions, amine synthesis.

Protecting Groups

Principles of protection of alcohol, amine, carbonyl and carboxyl groups.

Unit-IV **15 Hrs**

One Group C-C Disconnections

Alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, 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.

Elective: SET-B & SET-E
Organic Chemistry (OC)

M.Sc. Chemistry IVth Semester
Medicinal Chemistry
Theory Elective - IV

Course code: CHL-545-OC/PH
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 drug design and synthesis of medicinally important molecules.

Unit-I **15 Hrs**

Drug Design

Introduction, development of new drugs, structure-activity relationship (SAR) - isosterism, bio-isosterism. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship, Concepts of drugs receptor, Elementary treatment of drug receptor interactions, Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric factors.

Unit-II **15 Hrs**

Antineoplastic Agents

Introduction, role of alkylating agents and antimetabolites in treatment of cancer. Synthesis and uses of the following antineoplastic agents: mechlorethamine, cyclophosphamide, melphalan, uracil and 6-mercapto purine, Introduction to taxol.

Antibiotics

Cell wall biosynthesis inhibitors, antibiotics inhibiting protein synthesis, Synthesis and uses of the following antibiotics: penicillin G, amoxycillin, cephalosporin, ciprofloxacin. Introduction to tetracycline and streptomycin.

Unit-III **15 Hrs**

Cardiovascular Drugs

Introduction, synthesis and uses of ditiazem, verapamil, methyldopa and atenolol.

Local Antiinfective Drugs

Introduction, Synthesis and uses of the following local antiinfective drugs: furazolidone, nalidixic acid, dapsone, isoniazid, ethambutol, gluconazole, chloroquin and primaquin.

UNIT-IV **15 Hrs**

Psychoactive Drugs – The Chemotherapy of Mind

Introduction to neurotransmitters, general anaesthetics, sedatives, anti-anxiety drugs, benzodiazopines, Antipsychotic drugs – the neuroleptics, antidepressants, butyrophenones. Synthesis of diazepam, alprazolam, phenyltoin , buspirone and glutethimide.

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. An Introduction to Drug Design, S.S. Pandeya and J.R. Dmmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1, Ed. M E Wolff, John Wiley.
5. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.

Elective: SET-B
Organic Chemistry (OC)

M.Sc. Chemistry IVth Semester
Organic Chemistry Practical-V
Practical elective-III

Course code: CHP-546-OC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I Qualitative Analysis

Separation of binary mixture (solid + liquid and liquid + liquid) and Characterization with the help of chemical analysis and confirmation of their structures with the help of UV, IR, NMR and MS spectral data.

II Multi-Step Synthesis of Organic Compounds

The exercises should illustrate the use of organic reagents and may involve purification of products by chromatographic techniques.

Photochemical reaction
Beckman rearrangements
Benzilic acid rearrangements
Synthesis of Heterocyclic Compounds, 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.
3. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
4. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
6. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
7. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.

Elective: SET-C
Physical Chemistry (PC)

M.Sc. Chemistry IVth Semester
Solid State & Biophysical Chemistry
Theory Elective - III

Course code: CHL-544-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 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. Biochemistry, L. Stryer, W.H. Freeman.
2. Biochemistry, J. David Rawn, Neil Patterson.
3. Biochemistry, Voet and Voet, John Wiley.
4. Lehninger Principles of Biochemistry, M.M. Cox and D.L. Nelson, Freeman and Company.
5. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, H. Dugas and C. Penny, Springer-Verlag.
6. Solid State Chemistry and its Applications, A.R. West Plenum.
7. Principles of the Solids State, H.V. Keer, Wiley Eastern.
8. Solid State Chemistry, N.B. Hannay.
9. Solid State Chemistry, D.K. Chakrabarty, New Age International

Elective: SET-C & SET-F
Physical Chemistry (PC)

M.Sc. Chemistry IVth Semester
Physical Polymer Chemistry
Programme Elective - IV

Course code: CHL-545- PC/PO
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 **15Hrs**

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 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.

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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

Elective: SET-C
Physical Chemistry (PC)

M.Sc. Chemistry IVth Semester
Physical Chemistry Practical-V
Practical Elective-III

Course code: CHP-546-PC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

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 Potentiometry

3. Determine the solubility and solubility product of an insoluble salt AgX (X=Cl, Br, I) potentiometrically.
4. Determine the mean activity coefficient of 0.01M HCl solution.
5. Find out pH values of three buffer solution using (a) indicator (b) pH–Meter (c) Potentiometer.

IV Spectroscopy

6. Record the UV Spectrum of a given compound (acetone) in cyclohexane:
   a) Plot transmittance vs. wavelength, b) Plot absorbance vs. wavelength.
   c) Assign the transitions by recording spectra in solvents of different polarities (H_2O, CH_3OH, $CHCl_3$, CH_3CN and 1,4-dioxane). Calculate hydrogen bond energy.
   d) Calculate the oscillator strength/ transition probability.
7. Record the UV spectra of Benzene, pyridine and pyrimidine in methanol. Compare and discuss the various transitions observed.
8. Record the IR spectrum of few compounds and their characterization (bond strength/energy)
9. Experiment on formation and study of adsorption isotherm by UV.
10. Experiment on formation and study of micelles.

V Computational Techniques

11. 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. vander Wall's equation)
    e) Least square fit including graphic
    f) Chemical kinetics
12. 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.
6. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw-Hill.

M.Sc. Chemistry IVth Semester
Seminar

Course code: CHS-547

60 Hrs (4Hrs /week) **Credits: 2**
Total Marks: 100

Students will be required to prepare a report of selected topics in Chemistry and Allied subjects, and submit in the form of typed report. The students will be required to make a detailed oral presentation of the topic.

Electives SET-D
Analytical Chemistry (AC)

M.Sc. Chemistry III Semester
Electrochemical Methods
Theory Elective -III

Course code: CHL-532-AC
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.*

Objective: This paper deals with electrochemical methods and solvent extraction.

Unit – I **15 Hrs**

Potentiometry

Introduction to electrode potentials**,** general principles of potentiometry, reference electrodes, liquid junction potentials, indicator electrodes, instruments for measuring cell potential, direct potentiometry, potentiometric titrations, potentiometric determination of equilibrium constants.

Coulometry

Controlled-potential coulometry, controlled- current coulometry, applications.

Unit – II **15 Hrs**

Voltammetry

Excitation signals, linear potential sweep voltammetry- voltammetric instruments, voltammetric electrodes, hydrodynamic voltammety- voltammetric currents /voltage for reversible and irreversible reactions, voltammograms for mixtures, oxygen wave, cyclic voltammetry.

Stripping voltammetry: anodic, cathodic and adsorptive stripping techniques. Chemically modified electrodes. Voltammetric applications.

Unit-III **15 Hrs**

Polarography

General principle and instrumental set up of polarography, concepts and expressions of diffusion current, half wave potential, residual current, droping mercury electrode, differential pulse polarography, square –wave polarography, current-potential curve and applications.

Fundamental principles of amperometric titrations, instrumentation and titration procedures, advantages and disadvantages of amperometric titrations.

Unit – IV **15 Hrs**

Solvent Extraction

Distribution coefficient (K_D), distribution ratio (D), percent extraction (%E), multiple batch extraction, solvent exatraction of metals and separation efficiency (β) of metal complexes, important examples: oxine for determination of iron, acetylacetone for determination of beryllium, diethyldithiocarbamate for determination of copper, dithizone for determination of lead; ion association complexes, determination of boron as ion association complexes; synergistic extraction, determination of nickel by synergistic extraction.

Books suggested:

1. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, CBS Publ. Delhi.
2. Fundamentals of Analytical Chemistry, D.A .Skoog, D.M.West, F .J .Holler, S.R.Crouch,Cengage Learning.
3. Analytical Chemistry,G.D.Christian,Wiley Publishers.
4. Instrumental Methods of Analysis, H. Kaur, Pragati Prakashan.

Elective: SET-D
Analytical Chemistry (AC)

M.Sc. Chemistry 3rd Semester
Analytical Chemistry Practical- III
Practical Elective -I

Course code: CHP-534-AC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

I pH-metry

1. To determine the dissociation constant of dibasic and tribasic acids.
2. Titration of mixtures of acids(HCl+ CH_3COOH) against strong base

II Spectrophotometry

1. Determination of P_{ka} of an indicator (e.g. methyl red) in (a) aqueous and (b) micellor meda
2. Determination of stoichiometry and stability constant of inorganic (e.g.ferri- salicyclic acid and organic (e.g. amine – iodine)
3. To determine the concentration of chromium and manganese in a binary mixture.

III Polarography

1. To study oxygen wave by polarography.
2. To characterize and determine Pb^{2+}, Cd^{2+} and Zn^{2+}, ions by polarography/ cyclic voltammetry.

IV Fluorometry

1. Determination of strength of vitamin B (Riboflavin) and aluminium

V Nephalometry

1. Determination of sulphate content in water sample.
2. Determination of phosphate content in water sample.

VI Chromatography: Column

1. Separation of Cu, Ni, Co by ion exchange method.

Books suggested:

1. Systematic Qualitative Organic analysis, H. Middleton, ACS publication.
2. Qualitative and Quantitative hand book of Organic analysis, H. Clark.
3. Vogel's Text Book of Practical Organic Chemistry, A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith.

Elective: SET-D
Analytical Chemistry (AC)

M.Sc. Chemistry IVth Semester
Analytical Chemistry
Theory Elective -III

Course code: CHL-544-AC
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 analysis of food, water pollution, soil, fuel, body fluid and drugs.

Unit – I **15 Hrs**

Food Analysis

Analysis of moisture content, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate in food products. Food adulteration- common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products. Exaction and purification of samples. HPLC, Gas Chromatography for organophosphates. Thin layer chromatography for identification of chlorinated pesticides in food products.

Unit-II **15 Hrs**

Water Pollution Analysis

Origin of waste water, types, water pollutants and their effects. Sources of water pollution- domestic, industrial, agricultural soil and radioactive wastes as source of pollution. Objectives of analysis- parameter for analysis- colour, turbidity, total solid, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates, and different forms of nitrogen. Heavy metal pollution- Public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Measurements of DO, BOD and COD. Pesticides as water pollutants and analysis. Water pollution laws and standards.

Unit-III **15 Hrs**

Soil and Fuel Analysis

Analysis of soil: moisture, pH, total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts. Fuel analysis: solid, liquid and gas. Ultimate and proximate analysis, heating values- grading of coal. Liquid fuels- flash point, aniline point, octane number and carbon residue, Gaseous fuels- producer gas and water gas- calorific value.

Unit-IV **15 Hrs**

Body Fluids and Drugs Analysis

Clinical chemistry: Composition of blood- collection and preservation of samples. Clinical analysis. Serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphatases. Immunoassay: Principle of radio immunoassay (RIA) and applications. The blood gas analysis- trace elements in the body. Drug analysis: narcotics and dangerous drugs.

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.

Elective: SET-D
Analytical Chemistry (AC)

M.Sc. Chemistry IVth Semester
Analytical Chemistry Practical –V
Practical Elective-III

Course CHP-546-AC
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

1. Determination of the total nitrogen content of soil, manure or a fertilizer.
2. Determination of phosphate content of the given soil extract, fertilizer solution or phosphate rock solution.
3. Determination of ash/moisture content of a coal/coke sample.
4. Determination of sulphur content of a sample of coal.
5. Determination of the amount of copper in a solution of copper ore or brass.
6. Determination of available oxygen in pyrolusite by $KMnO_4$.
7. Determination of the amount of calcium in limestone.
8. Determination of total acid number of fuel oil.
9. Determination of iodine value of fuel oil.
10. To perform the chemical test of constituents of urine.
11. To study digestive enzyme salivary amylase.
12. To study the chemical composition of wheat flour.
13. Testing of various adulterants in food products.

Books suggested:

1. Applied Chemistry, O.P. Vermani, A.K. Narula, New Age International.
2. Practical Inorganic Chemistry, Marr and Rocket.
3. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G.H. Jeffery and J. Mendham, ELBS.

Elective: SET-E
Pharmaceutical Chemistry (PH)

M.Sc. Chemistry IIIrd Semester
Pharmaceutical Chemistry-I
Theory Elective-I

Course code: CHL-532-PH
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 pharmaceutical sciences.

Unit-I **15 Hrs**

Combinatorial Chemistry `

Introduction, Combinatorial approaches, solid phase techniques, liquid phase synthesis, Chemical Peptide and small molecular libraries, split synthesis and parallel synthesis- applications and methodology, deconvolution, Combinatorial Organic Synthesis, High throughput screening (HTS), Planning and designing a combinatorial synthesis-scaffolds, X-ray crystallography, docking procedures.

Unit-II **15 Hrs**

Stability Testing of Drugs

Drug substance – criteria, storage conditions, long term testing, accelerated testing, frequency, evaluation, labelling; Drug product – Selection of batches criteria, specification, conditions of storage and testing, Calculation of shelf life and expiry date of products Quality control and Quality Assurance: Requirements of GMP, cGMP, GLP, ISO-9000, regulatory requirements of drugs and pharmaceutical (USFD-NDA/ANDA), total quality management (TQM) concept.

Unit– III **15 Hrs**

Introductory Pharmacology

Drug administration, distribution, metabolism and elimination (ADME); Pathways of drug metabolism, enzymology and molecular mechanisms, dose formulations.

Unit – IV **15 Hrs**

Pharmaceuticals

New drug products– Dissolution, disintegration, hardness friability, uniformity of dosage units, water contents, microbial limits; Introduction to Oral liquids, Parenteral products and tablets; Preformulation studies: study of physical properties of drugs like physical form, particle size, shape, density wetting dielectric constant, solubility, dissolution and organoleptic properties; study of chemical properties of drugs like hydrolysis, oxidation, reduction, racemization and polymerization.

Books Suggested:

1. Medicinal Chemistry– a biochemical approach, T. Nogrady
2. Principles of medicinal chemistry, W.O. Foye
3. The pharmacological basis of therapeutics, Goodman and Gilman
4. Introduction to drug metabolism, G.G. Gibson and P. Skett.
5. Combinatorial Chemistry

Elective: SET-E
Pharmaceutical Chemistry (PH)

M.Sc. Chemistry IIIrd Semester
Pharmaceutical Chemistry Practical-III
Practical Elective-I

Core Course CHP-534-PH
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

Preparation and evaluation of the following:

Emulsion, simple syrup , aqueous iodine solution, strong iodine solution, calamine lotion, boroglycerine, lannic acid/glycerine, phenol/glycerine, pipermint water, roses water, non-staining iodine ointment cum methyl salicylate, formulation of simple and medicated ointments, magnesium hydroxide mixture (milk of magnesium), simple and complex powders.

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.
3. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
4. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
6. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
7. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.

Elective: SET-E
Pharmaceutical Chemistry (PH)

M.Sc. Chemistry IVth Semester
Pharmaceutical Chemistry-II
Theory Elective - III

Course code: CHL-544-PH
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 different aspects of pharmaceutical chemistry including synthesis and applications of important drugs.

Unit-I **15 Hrs**

General mode of action, Uses and Synthesis of Important Drugs

Introduction to AIDS, mode of action of nucleoside reverse transcriptase inhibitors- AZT, ddI, ddC, d4T & 3TC and HIV-protease inhibitors- Ritonavir. Synthesis of AZT. An overview of HIV entry inhibitors, Integrase inhibitors, Chemokine receptor binders, Inhibitors of gp41 fusion activity Antimalarials: Cinchona alkaloids, 4-amino quinolines, 8-aminoquinolines, mefloquine, 9-aminoacridines. Synthesis of metaquine.

Unit-II **15 Hrs**

β-Lactam Antibiotics Penicillins

Discovery, mode of action, SAR, Penicillins and semi-synthetic penicillins, problems of sensitivity to acids, β-lactamases and narrow spectrum of activity, synthesis of oxacillin, cloxacillin, ampicillin, amoxycillin, carbenicillin and carfecillin, β-lactamase inhibitors-Clavulanic acid, Olivanic acids

Unit-III **15 Hrs**

Antibiotics

Classification, SAR, synthesis of cephalosporin-C, recent advances of fourth generation cephalosporins

SAR, mode of action, Sulfanilamide analogs- synthesis of Sulfathiazole, sulfadiazine, sulfacetamide

Macrolides- mode of action, erythromycin, azithromycin, Synthesis of chloramphenicol, Quinolones, fluoroquinolones. Structure, mode of action of nalidixic acid, ciprofloxacin and lincomycins

Unit-IV **15 Hrs**

Non-Steroidal Anti-inflammatory Agents

Classification, mode of action, COX-2 inhibitors, salol principle Synthesis of celecoxib, valdecoxib, aspirin, phenbutazone, mefanamic acid, indomethacin, piroxicam, diclofenac, Naproxen.

Antipyretic-Analgesics

Opoid antagonists and agonists-codeine and heroin, synthesis of meperidine, methadone, dextropropoxyphen

Antifertility Agents

Ovulation inhibitors and related hormonal contraceptives- norethindrone, norethynodrel, estradiol and mestranol.

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. An Introduction to Drug Design, S.S. Pandeya and J.R. Dmmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1, Ed. M E Wolff, John Wiley.
5. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
6. Principles of medicinal chemistry, W.O. Foye
7. The pharmacological basis of therapeutics, Goodman and Gilman

Elective: SET-E
Pharmaceutical Chemistry (PH)

M.Sc. Chemistry IVth Semester
Pharmaceutical Chemistry Practical-V
Practical Elective-III

Course code: CHP-546-PH
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

1. Determination of specific rotation of ibuprofen and determination of its percentage in the unknown sample.
2. Volumetric determination of ibuprofen in the given tablet.
3. Spectrophotometer determination of aspirin content in the soluble aspirin table.
4. Spectrophotometer determination of paracetamol in the tablet.
5. Determination of Vitamin C in given formulation.
6. Determination of phenobarbitone in the given cough syrup.
7. To perform I.P. monograph of tablet
8. To perform I.P. monograph of hard gelatine capsule.

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.
3. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
4. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
5. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
6. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
7. Analytical Organic Chemistry, Jag Mohan, Narosa Publishers.
8. Indian pharmacopeia.

Elective: SET-F
Polymer Chemistry (PO)

M.Sc. Chemistry IIIrd Semester
Polymer Synthesis and Processing
Theory Elective-I

Course code: CHL-532-PO
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 synthesis, applications and processing of polymers.

Unit-I **15 Hrs**

Synthesis, Properties and Applications of Polymers-I

Polystyrene and other related polymers, copolymers of polystyrene, acrylic polymers– acrylic fibers, acrylic adhesives, polyacrylates, polymethyl methacrylate, polyacrylamide. Polyvinyl acetate, polyvinyl alcohol.

Natural rubber and other isoprene polymers, rubbers derived from butadiene– acrylic acid copolymers, stereoregular polybutadienes, polychloroprene (neoprene), styrene-butadiene-acrylonitrile copolymers.

Unit-II **15 Hrs**

Synthesis, properties and Applications of Polymers-II

Polyamides- Nylon 66, Nylon 610, polyesters, polyether and related polymers– poly ethylene terephthalate, polybutyllene, terphthalate, aromatic polyesters, polycarbonate, polyurethanes– Flexible and rigid polyurethane, polyurethane elastomers, sulphur containing polymers. Thermosetting resins-epoxy resins.

Unit-III **15 Hrs**

Rheology and Principles of Processing

Introduction, melt processing of thermoplastics- hygroscopic, granule characteristics, thermal properties influencing polymer melting and cooling, thermal stability, flow properties (rheology) and effects, crystallization, orientation and shrinkage. Melt processing of thermosetting plastics, processing in rubbery state, solution, suspension and casting processes. Introduction to principles of product design. Introduction to mixing.

Extrusion and Blow Moulding

Fundamental principles, operation of single screw & twin screw extruders, flow mechanism, some aspects of screw design and die characteristics. Extrusion based processes- profile and pipe production, film blowing, sheet, coating and cast films, stretch blow moulding, co-extrusion.

Unit-IV **15 Hrs**

Injection Moulding

Introduction, process and essential elements of injection moulding machine– injection unit, nozzle, clamp unit and mould, mould clamping force. Some aspects of product quality– basis of material

response, design aspect, effect of shear heat and pressure, orientation and shrinkage. Reaction injection moulding.

Compression, Transfer Moulding and Calendering

Materials- factors to be considered while processing, preheating process, procedure, advantages and limitations of compression moulding, introduction to transfer moulding, advantages and limitations of transfer moulding. Features of various type of calenders and calendering operations.

Books Suggested:

1. Principles of polymerization, G.Odian, Wiley – Interscience.
2. Organic Polymer Chemistry, K.J. Saunders, Chapman and Hall.
3. High Performance Polymers, Their Origin and Development, R.B. Seymour and G.S. Kirshenbaum, Elsevier.
4. Organic Chemistry of Synthetic High Polymers, Robert W. Lenz, Interscience Publisher.
5. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc.
6. Plastics Materials, J.A. Brydson, Butterworth Scintific.
7. Polymer Chemistry, Seymour and Carraher, Marcel Dekker.
8. Plastic Technology, Patten, W. J., D. Bavaporwala.
9. Principles of Polymer Processing by Fenner R.T., Chemical Publishing N.Y.
10. Synthetic Rubber, G.S. Whitby, John Wiley & Sons.
11. Polymer science, a Material Science H.B. Vol I & II. A.D. Jenkins, North Holland.
12. Polymer Processing, Morton & Jones, Chapman & Hall.
13. Plastics Engineering, R.J. Crawford, Maxwell Macmillan International.
14. Plastics Engineering Handbook, M.L. Berins, Van Nostrand Reinhold.
15. Plastics Engineering Handbook, Joel Frados, Van Nostrand Reinhold.
16. Plastics Extrusion Technology, Friedhlm Hanser, Hanser Publications.
17. Flow of High Polymers, S. Middleman, Interscience Publishers.

Elective: SET-F
Polymer Chemistry (PO)

M.Sc. Chemistry IIIrd Semester
Polymer Chemistry Practical-III
Practical Elective-I

Course code: CHL-534-PO
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

Polymer synthesis

1. Free radical solution polymerization of Styrene/MMA.
2. Preparation of nylon 66/6/610.
3. Redox/solution polymerization of acrylamide.
4. Precipitation polymerization of acrylonitrile.
5. Preparation of urea-formaldehyde/melamine-formaldehyde resin.
6. Preparations of Novolac resin/resol resin (PF).
7. Emulsion/Suspension polymerization of methyl acrylate.
8. Synthesis of epoxy/unsaturated polyester resin.

Polymer modifications

9. Preparation of cellulose acetate and Film casting from solutions.
10. Preparation of poly (vinyl alcohol) from poly (vinyl acetate).

Polymer analysis

11. To determine acid value of a given polymer.
12. To determine sap. value and %purity of plasticizer.
13. To determine epoxy content of given polymer by pyridiumchloride/ pyrinine method.
14. Analysis of formalin, phenol, substituted phenol, epichlorohydrine, plasticizer.
15. Determination of Hydroxy value/K-Value/carboxyl.
16. Identification of plastics by heating/burning tests.

Books Suggested:

1. Analysis of polymers- an introduction, Crompton T.R., Pergaman press.
2. Thermal characterization of polymeric materials, E.A. Turi, Academic Press.
3. Polymer science, a material science H.B. Vol I & II, A.D. Jenkins, , North Holland publishing.
4. Handbook of Plastics Analysis, H. Lobo and J. V. Bonilla, Marcel Dekker.

Elective: SET-F
Polymer Chemistry (PO)

M.Sc. Chemistry IVth Semester
Advance Polymer Chemistry
Theory Elective-III

Course code: CHL-544-PO
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 structure-property relations and advance applications of polymers.

Unit-I **15 Hr**

Polymer Structure-property Relations

General considerations, control of T_m and T_g, relation between T_m and T_g, random copolymers, dependence of T_m and T_g on copolymer composition, block copolymers, crystallinity and mechanical response, application to fibres, elastomers and plastics, fibres, aromatic polyamides, polyethylene, elastomers and crosslinked networks, high temperature specialty polymers, carbon fibres.

Structural evaluation of polymers

Principles, theories and applications to polymeric systems with suitable illustration of the following techniques: FTIR, NMR, XRD, etc.

Unit-II **15 Hr**

Polymer Degradation and Stabilization

Introduction, types of degradation- thermal degradation, mechanical degradation, photo degradation, degradation by high-energy radiation, oxidative degradation and hydrolytic degradation and biodegradation. Stabilization of polymers with case study. Biodegradable polymers and environmental aspects of polymers

Additives for Polymers

Introduction, fillers and reinforcements, plasticizers and softners, lubricants and flow promoters, anti-aging additives (antioxidants etc,), colorants, flame retardants, blowing agents, cross-linking agents and miscellaneous additives.

Unit-III **15 Hr**

Liquid Crystalline Polymers

Introduction, liquid crystal phases, identification of mesophases, lyotropic main chain liquid crystal polymers, thermotropic main chain liquid crystal polymers, side chain liquid crystal polymers, chiral nematic liquid crystal polymers, miscellaneous structures

Polymers for Electronics Industry

Introduction, lithographic process, polymer resists, photolithography, electron and x-ray sensitive resists, conduction mechanism and preparation of few conducting polymers, non-linear optics, Langmuir-Blodgett films, optical information storage, thermo-recording on liquid crystalline polymers.

Biomedical Polymers

Introduction and some examples.

Unit-IV **15 Hr**

Polymer Blends and Alloys

Introduction, thermodynamics and phase behavior, some examples of commercially available polymer blends, preparation and applications.

Polymer Nanocomposites

Introduction, few examples of polymer composites, introduction to polymer nanocomposites, applications.

Silicones, Heat-resistant and Fire-retardant Polymers

Introduction, preparation, properties and applications of silicone resins & silicone rubbers in brief. Introduction to heat-resistant and fire-retardant polymers, few examples of such commercially available polymers.

Recycling and disposal of plastics.

Books Suggested:

1. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc.
2. Plastics Additive Handbook, Gachter and Mullar, Hanser Publishers.
3. Photochemical Conversion and Stabilization of Polymers, V. Shlyapitokh, Hanser Publication.
4. Polymer Chemistry, Malcolm P. Stevens, Oxford University Press, Inc.
5. Introduction to Polymer Science and Technology, H.S. Kaufman and J.J. Falcetta, Wiley Interscience Publication.
6. Plastics Materials J. A. Brydson, Butterworth Scientific.
7. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony.
8. Fillers and Filled Polymers, J.F. Gerard, Wiley-VCH Verlag GmbH.
9. Handbook of Fillers, G. Wypych, Chem Tech Publishing.
10. Composite Polymeric Material, R.P. Sheldon, Applied Science Publishers.
11. Composite Material Handbook, M.M. Schwartz, McGraw-Hill company.
12. Polymer Blends & Alloys, L.A. Utraki.
13. Biopolymers, Wiley, VCH Verlag.

Elective: SET-F
Polymer Chemistry (PO)

M.Sc. Chemistry IVth Semester
Polymer Chemistry Practical-V
Practical Elective-III

Course code: CHL-546-PO
120 Hrs (8Hrs /week) **Marks for Major Test (External): 70**
Credits: 4 **Marks for Internal Exam: 30**
Time: 6 Hrs **Total Marks: 100**

Polymer Characterization and Testing

1. Determination of molecular weight by viscometry: (i) PS-toluene/benzene (ii) polyacrylamide- aq. $NaNO_2$ solution (iii) poly (methyl acrylate) - toluene/benzene.
2. Determination of molecular weight by end group analysis PEG.
3. Determination of hydroxyl No. of polymer using colorimetric method.
4. Quantitative determination of impurities in given polymer by spectral techniques (UV-VIS).
5. IR/ NMR studies of polymer samples.
6. To find T_g, T_c, and T_m of given polymer/resin by DSC.
7. Degradation and stability of polymers by thermal analysis by thermal techniques.
8. Determination of melt flow index (MFI) of given sample of polymer.
9. Flammability tests of plastics (LOI/UL 94).
10. Determination of Vicat's Softening point of given sample of thermoplastics.
11. Determination of Heat distortion temperature of plastic sheets.
12. Determination of impact strength of plastic films/sheets.
13. Mechanical testing (stress-strain behavior): Tensile strength, Elongation, Flexural strength, Modulus/energy.
14. Determination of Abrasion resistance of rubber and Adhesion (tear strength),
15. Determination of Hardness (Shore D), sp. Gravity and bulk density of rubber.
16. Processing methods (Extrusion/Injection/Compression/blow moulding)/ Vulcanization process.

Books Suggested:

1. Analysis of Polymers- An introduction, T.R. Crompton, Pergaman press.
2. Thermal Characterization of Polymeric Materials, E.A. Turi, Academic press Inc.
3. Polymer Science, a material science H.B. Vol I & II, A.D. Jenkins, , North Holland publishing co., Amsterdam London.
4. Carbon-13 Nuclear Magnetic Resonance for organic chemists, G.C. Levy and G.L. Nelson, Wiley Interscience.
5. Polymer sequence determination: carbon- 13 NMR method by James Crandall, Academic press.
6. Handbook of Polymer Testing Roger Brown, Marcel Dekker Inc.
8. Instrumental Methods, Dyer.
9. Developments in Polymer Characterization 1-5, J. V. Dawkins.