

GULBARGA UNIVERSITY, GULBARGA



Department of P.G. Studies and Research in Chemistry

Syllabus for

M.Sc. Course in Chemistry

Under

Choice Based Credit System (CBCS)

From Academic Year 2011-12 onwards



Gulbarga



University

Department of Studies and Research in Chemistry

**Course Outline and Syllabus for Master of Science (M. Sc) in CHEMISTRY
Under CBCS and CAGP (Effective from the academic year 2011-2012)**

Semester	Code	Title of the Course	Semester Exam	IA	Total	L	T	P	Credits
		Hard Core							
First	HCT1.1	Inorganic Chemistry-I	80	20	100	4	0	0	4
	HCT1.2	Organic Chemistry-I	80	20	100	4	0	0	4
	HCT1.3	Physical Chemistry-I	80	20	100	4	0	0	4
		Soft-Core (Any One)							
	SCT1.1	Analytical Chemistry-I	80	20	100	4	0	0	4
	SCT1.2	Pharmaceutical Chemistry	80	20	100	4	0	0	4
		Practical							
	HCP1.1	Inorganic Chemistry Practical –I	40	10	50	0	0	2	2
	HCP1.2	Organic Chemistry Practical –I	40	10	50	0	0	2	2
	HCP1.3	Physical Chemistry Practical-I	40	10	50	0	0	2	2
		Soft-Core (Any One)							
	SCP1.1	Analytical Chemistry Practical –I	40	10	50	0	0	2	2
	SCP1.2	Pharmaceutical Chemistry Practical	40	10	50	0	0	2	2
		Total for First Semester	480	120	600				24
Second		Hard Core							
	HCT2.1	Inorganic Chemistry-II	80	20	100	4	0	0	4
	HCT2.2	Organic Chemistry-II	80	20	100	4	0	0	4
		Soft Core (Any One)							
	SCT2.1	Analytical Chemistry-II	80	20	100	4	0	0	4
	SCT2.2	Physical Chemistry-II	80	20	100	4	0	0	4
		Open Elective (Any One)							
	OET2.1	Chemistry-I (Analytical)	80	20	100	4	0	0	4
	OET2.2	Chemistry-II (Physical)	80	20	100	4	0	0	4
		Practical							
	HCP2.1	Inorganic Chemistry Practical –II	40	10	50	0	0	2	2
	HCP2.2	Organic Chemistry Practical –II	40	10	50	0	0	2	2
		Soft Core (Any One)							
	SCP2.1	Analytical Chemistry Practical-II	40	10	50	0	0	2	2
	SCP2.2	Physical Chemistry Practical –II	40	10	50	0	0	2	2
		Open Elective (Any One)							
	OEP2.1	Chemistry Practical-I (Analytical)	40	10	50	0	0	2	2
	OEP2.2	Chemistry Practical-II (Physical)	40	10	50	0	0	2	2
		Total Second Semester	480	120	600				24

Semester	Code	Title of the Course	Semester Exam	IA	Total	L	T	P	Credits
		Hard Core							
Third	HCT3.1	Organic Chemistry-III (Spectroscopy)	80	20	100	4	0	0	4
	HCT3.2	Physical Chemistry-III	80	20	100	4	0	0	4
		Soft-Core (Any One)							
	SCT3.1	Analytical Chemistry-III	80	20	100	4	0	0	4
	SCT3.2	Inorganic Chemistry-III	80	20	100	4	0	0	4
		Open Elective (Any One)							
	OET3.1	Chemistry-III (Inorganic)	80	20	100	4	0	0	4
	OET3.2	Chemistry-IV (Organic)	80	20	100	4	0	0	4
		Practical							
	HCP3.1	Organic Chemistry Practical –III	40	10	50	0	0	2	2
	HCP3.2	Physical Chemistry Practical-III	40	10	50	0	0	2	2
		Soft-Core (Any One)							
	SCP3.1	Analytical Chemistry Practical-III	40	10	50	0	0	2	2
	SCP3.2	Inorganic Chemistry Practical–II	40	10	50	0	0	2	2
		Open Elective (Any One)							
	OEP3.1	Chemistry Practical-III (Inorganic)	40	10	50	0	0	2	2
	OEP3.2	Chemistry Practical-IV (Organic)	40	10	50	0	0	2	2
		Total for Third Semester	480	120	600				24
Fourth		Hard Core							
	HCT4.1	Inorganic Chemistry-IV	80	20	100	4	0	0	4
	HCT4.2	Physical Chemistry-IV	80	20	100	4	0	0	4
		Soft Core (Any One)							
	SCT4.1	Analytical Chemistry-IV	80	20	100	4	0	0	4
	SCT4.2	Special Topics in Org. Chem.	80	20	100	4	0	0	4
		Practical							
	HCP4.1	Inorganic Chemistry Practical-IV	40	10	50	0	0	2	2
	HCP4.2	Physical Chemistry Practical–IV	40	10	50	0	0	2	2
		Soft Core (Any One)							
	SCP4.1	Analytical Chemistry Practical-IV	40	10	50	0	0	2	2
	SCP4.2	Organic Chemistry Practical -IV	40	10	50	0	0	2	2
	HCMP4.3	Major Project	120	30	150	0	0	6	6
		Total Fourth Semester	480	120	600				24

L = Lecture; T = Tutorials; P = Practical's; 4 Credits of Theory = 4 Hours teaching per week

2 Credits of Practical's = 4 Hours per week

Scheme of Practical Exam: Expts-30 Marks, Viva-voce-5 Marks, Record-5 Marks = 40 Marks

Major Project: Project Evaluation-90 Marks & Viva-voce-30 Marks = 120 Marks

CHEMISTRY (CBCS Scheme)
SEMESTER – I
HCT 1.1: INORGANIC CHEMISTRY – I

**Types of Bonding, Stereo
chemistry of Coordination Compounds, Acid-base Concepts
(64 Hours)**

UNIT – I

Ionic bonding: Properties of ionic compounds, lattice energy, Born-Land's equation, Born-Haber cycle and its applications, Kapustinskii equation, Solvation energy, dissolution of ionic compounds in polar solvents and their energetics. The predictive power of thermochemical calculations of ionic compounds, covalent character in ionic compounds. Radius ratio and structure of ionic compounds and efficiency of packing of crystal lattices.

Covalent bonding: Valence bond theory, orbital overlap, molecular orbital theory, symmetry and overlap, molecular orbital diagrams of diatomic molecules (homo- and hetero- nuclear), triatomic molecules, linear (CO_2 , N_2O) and angular (NO_2), Walsh diagrams, Bent rules, some reactions of covalently bonded molecules, Resonance, hybridization, VSEPR theory, molecular geometries. **[16 Hours]**

UNIT – II

Metallic bonding: Characterization of metallic states, VB approach, band theory, conductors, insulators, semiconductors, defects in solids.

Metal π -Complexes: Preparation, structure, bonding and important reactions of metal carbonyls, metal nitrosyls, dinitrogen and dioxygen complexes. **[16 Hours]**

UNIT – III

Stereochemistry of Coordination Compounds: Coordination geometry, types of isomerism (geometrical & optical). Review of bonding theories; Molecular orbital theory/Ligand field theory (octahedral, tetrahedral and square planar complexes), MO theory applied to complexes with π -bonding. Evidences for metal-ligand orbital overlap, spectrochemical series and Jahn-Teller distortion in coordination compounds.

Magnetism: Types of magnetism; magnetic susceptibility; spin only moment; orbital contribution to spin only moment. **[16 Hours]**

UNIT – IV

Review of Acid-Base Concepts: Introduction, different definitions, types of reactions, solvent system and leveling effect. A generalized acid-base concepts (basicity of metal oxide, hydration and hydrolysis). Measurement of Acid-Base strengths, Steric effect (back strain, front strain and Internal strain). Solvation effects with reference to liquid ammonia, anhydrous sulfuric acid, acetic acid and liquid sulfuredioxide. Hard-Soft Acids and Bases; classification, strength of hardness and softness; Irving William series; theoretical basis of hardness and softness. **[16 Hours]**

Books Recommended:

1. Advanced Inorganic chemistry - F.A.Cotton and Wilkinson, John-Wily and sons
2. Chemistry of the Elements - N.N.Greenwood and A. Eamshaw, Pergamon
3. Concise Inorganic Chemistry - J.D. LEE, ELBS
4. Inorganic Chemistry, Principles and Reactivity – J.E.Huheey, Harper and Row
5. Modern aspects of Inorganic Chemistry – H.J. Emuleus and A.G.Sharpe ELBS
6. Theoretical Inorganic Chemistry - M.C.Day, Jr. an J.Selbin East-West press
7. Concept and Model's in Inorganic Chemistry – Dougals, McDanial and Alexander John Wiley and sons.
8. Inorganic Qualitative Analysis - A.I.Vogel ELBS
9. Fundamentals of Analytical Chemistry - D.A.Skoog, D.M.West and F.T.Holler, Saunder college publishing
10. Inorganic Quantitative methods - Alexeev Mir publications
11. Principles of Inorganic Chemistry – Puri, Sharms and Kalia-Shobanlal-Nagin.
12. An Introduction to Inorganic Chemistry – Purcell and Kotz-Holt-Saunders
13. Coordination Chemistry-S.F.A. Kettle.
14. Comprehensive coordination Chemistry – G. Wilkinson, R.D. Gillars and J.A.Mcclevertry, Pergamon

HCP 1.1: INORGANIC CHEMISTRY PRACTICAL-I

(64 Hours)

Part-A

Semimicro qualitative inorganic analysis of a mixture.

Mixture containing three cations and three anions including one less common cations such Mo, Ti, Zr, Ce, V and Li and one interfering anion.

Part-B

i) Determination total hardness of water.

ii) Determination of Nickel by complexometry (by back titrations).

iii) Preparation of hexamine nickel (II) chloride complex.

Books Recommended:

1. Chemical Semi micro analysis- V.N.Alexeyev Mir Publishers (Mascow)
2. Vogel's Qualitative Inorganic analysis, Revised by G.Suchla Longarman group ltd.
3. Vogel's Text book of Quantitative Inorganic Analysis – J.Basett, R.C.Denney, G.H.Jeffery and J.Mendhaman, Longamans Green and Company Ltd.

HCT 1.2: ORGANIC CHEMISTRY-I

(64 Hours)

UNIT-I

Bonding in organic molecules and Aromaticity:

Localized chemical bonding: Hybridization index, Bonding in cyclopropane, Bond distances, Bond angles, Bond energies, Calculation of heats of reactions and Bond order.

Delocalized chemical bonding, Conjugation, Cross conjugation, Hyper conjugation, Resonance, Tautomerism, Valence tautomerism and bonding in fullerenes.

Bonding weaker than covalent: Hydrogen bonding and Inclusion compounds.

Aromaticity: Aromaticity and Huckel's rule-HMO theory, Benzenoid and Non benzenoid aromatic compounds. Tropones, Tropolones, Pylidium cation, Ferrocene. Alternant and nonalternant hydrocarbons. Aromaticity of charged rings (3 to 8 membered), non aromatic, antiaromatic and homo aromatic systems, methods for their determination: X-ray, UV and NMR techniques. Annulenes and Hetero annulenes [10-18].

[16 Hours]

UNIT-II

Reaction Mechanism:

Classification of Organic Reactions – meaning and importance of reaction mechanism. Methods of determination of reaction mechanisms.

Kinetic Methods: Order and Molecularity.

Non-Kinetic Methods: Product identification, Cross over experiments, Study of intermediates, Isotopic labeling, Kinetic Isotope effects, Stereochemical studies. Mechanisms of aliphatic nucleophilic substitutions, SN^2 , SN^1 and SN^i , SRN^1 pathways. Rearrangements in SN^1 reactions. Structure, Stability and reactions of the following reactive intermediates: Carbocations (Classical and non-classical), Carbanions, Free radicals, Carbenes, Arynes, Nitrenes, Ylides and Enamines

[16 Hours]

UNIT-III

Stereochemistry and Conformational analysis:

Elements of symmetry and Symmetry operations and Point groups in small molecules.

Configurational notations of simple molecules, DL and RS configurational notations.

Optical isomerism: Optical activity, Chirality and Specific rotations. Molecules with two Chiral centers: Fischer, Saw-horse, Newman projections and their transformations. Enantiomers, Diastereomers, Epimers, Racemisation, Stereochemical correlation. Pseudo-asymmetric compounds.

Geometrical Isomerism: E-Z Nomenclature, Configuration of Geometrical Isomers, Syn and Anti isomers.

Conformational Analysis: Elementary account of conformational equilibria of ethane, butane and Curtin-Hammett principles.

[16 Hours]

UNIT- IV

Molecular rearrangements:

Classification and general mechanistic pattern for electrophilic, free radical and nucleophilic rearrangements.

Mechanism of the following rearrangement reactions:

C-C migration: Pinacol-Pinacolone, Dienone-Phenol, Benzil-Benzilic acid, Favorskii, Neber, Sommelet-Hauser, Anderson, Stevens, Smiles, Shapiro, Fritch-Butenberg-Wiechell rearrangements.

C-N migration: Benzidine, Hofmann, Curtius, Lossen and Beckmann rearrangements.

C-O migration: Baeyer-Villiger rearrangements.

O-C migration: Baker-Venkataraman, Fries and Wittig rearrangements. **[16 Hours]**

Books Recommended:

1. Organic Chemistry- P. Y. Bruice, Pearson, Education Pvt Ltd., New Delhi (2002).
2. Organic Chemistry- S. H. Pine, McGraw-Hill, London (1987)
3. Organic Chemistry- R. T. Morrison and R. T. Boyd, Prentice Hall, New Delhi, (1994).
4. Organic Chemistry- T. W. Graham, Solomones, Fourth Edition, John-Wiley and Sons (1988).
5. Organic Chemistry- G. M. Loudon, Fourth Edition, Oxford University Press, New York (2002).
6. Organic Chemistry- M. A. Fox and J. K. Whitusell, Second Edition, Jones and Bartlett Publishers, London (1997).
7. Organic Chemistry- F. A. Carey, Fourth Edition, McGraw- Hill (2000).
8. Advanced Organic Chemistry, Reactions, Mechanism and Structure- J. March, Third Edition, Wiley-Eastern Ltd., (2004).
9. Stereochemistry-Conformation and Mechanism-P. S. Kalsi, Wiley-Eastern Ltd., New Delhi (1992).
10. Guide book to Mechanism in Organic Chemistry- P. Sykes, Orient Longman, London.
11. Organic Chemistry Vol-I, II- I. L. Finar, 6th Edition, ELBS London (2004).
12. Stereochemistry of Organic Compounds, E. L. Eliel et. Al John Wiley and sons Inc.
13. Stereochemistry of Organic compounds, Principles and Applications- D. Nasipuri, Wiley Eastern Ltd. (1992).

HCP 1.2: ORGANIC CHEMISTRY PRACTICAL-I

(64 Hours)

PART - I: Preparation of following Organic compounds:

1. Benzoic acid and Benzyl alcohol from Benzaldehyde (Cannizarro reaction).
2. P-Chlorobenzoic acid from p-toluidine.
3. Aniline from Benzene.
4. m-Nitroaniline from Nitrobenzene.
5. m-Nitro benzoic acid from Ethyl benzoate.
6. P-Bromoaniline from Acetanilide.
7. p-Nitroaniline from Acetanilide.
8. Microscale experiments involving organic preparations.

PART – II: Quantitative Estimation of the following Organic compounds:

1. Acid.
2. Acid + Amide.
3. Acid + Ester.
4. Glucose.
5. Molecular weight determination by base hydrochloride method.

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry revised- B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, 5th Edition, Addison Wesley Longman Limited, UK, 1997.
2. A Hand book of Organic Chemistry- H. T. Clarke.
3. A Laboratory Manual of Organic Chemistry- B. B. Dey and M. V. Govindachari.
4. Experimental Organic Chemistry- L. M. Harwood and C.J.Moody, Blackwell Scientific, London, 1989.
5. Practical Organic Chemistry – W. Kemp, McGraw Hill, London, 1962.

HCT 1.3: PHYSICAL CHEMISTRY-I

(64 Hours)

UNIT - I

Quantum Chemistry:

A brief review of black body radiation, Photoelectric effect, Compton effect, de-Broglie's hypothesis, Heisenberg's uncertainty principle., Concept of operator - Addition, Subtraction, Multiplication of operators, Commutative, Linear, Del, Hermitian operators and their properties , Hamiltonian operators, eigenvalue and Eigen function. Postulates of quantum mechanics Schrödinger wave equation - wave function and its interpretation, elementary application to a particle in one dimensional box, particle in a ring and hydrogen atom. One dimensional harmonic oscillator. Conditions for orthogonality and normalization of wave functions Kronecker's delta. Criteria for the formation of atomic and molecular orbitals: Pauli's exclusion principle. Concept of σ , σ^* , π , π^* orbitals with characteristics. Hybrid orbitals. Comparison of M.O and V B. [16 Hours]

UNIT - II

Electrochemistry and Thermodynamics:

Activity and Activity co-efficient, Mean activity co-efficient, Debye-Huckel limiting law (qualitative aspect only) and assumptions. Ionic strength, thickness of ionic atmosphere. Basic concept of acids and bases, pH, pKa, pKw. Buffer action and capacity. Buffer solutions. Henderson Hasselbalch equation and its application in preparation of buffer. Importance of buffer in biological system.

Brief resume of concepts of laws of thermodynamics. Free energy, chemical potential and entropy. Gibbs-Helmholtz equation, Gibbs-Duhem and Maxwell's relation. Fugacity and its variation and determination of Duhem-Margules Equation and its application to thermodynamics of ideal and non-ideal solutions. [16 Hours]

UNIT - III

Polymer Chemistry:

Review of polymers, Basic concepts and classification of polymers - Monomer, Repeat units, Linear, Branched, Cross Linked, Straight, Copolymers and Networks and interpenetrating networks (IPN). Degree of polymerization. Molecular weight distribution - Average molecular weight concepts, Number Average, Weight Average, Viscosity Average and Z - Average molecular weights. Determination of molecular weights, Osmotic pressure method, viscosity method, light scattering (Debye and Zimm plots), Ultra centrifugation method, Polydispersity and molecular weight distribution, Practical significance of polymer molecular weight, Glass transition temperature (T_g) and Melting point and relation between them. Commercial importance of polymers. Size of Polymer molecules. [16 Hours]

UNIT - IV

Chemical Dynamics-1:

A brief review of basic concepts and terminology in reaction kinetics. Methods of determining rate laws. Steady state approximation, Arrhenius equation. Collision state theory for bimolecular reaction rates, Transition state theory. Comparison between collision and transition state theories. Lindemann and RRKM theories of unimolecular reaction rates. Concepts and significance of energy of activation.

Dynamics in solution: Ionic reactions, effect of ionic strength. Primary and secondary salt effects. Dynamics of Fast reactions, Relaxation methods, Flow methods (stopped flow and plugged flow), Flash photolysis methods. **[16 Hours]**

Books Recommended:

1. Molecular Quantum Chemistry P.W Atkins
2. Problems in Quantum Mechanics by G. L. Squires.
3. Introduction to Quantum Chemistry by A. K. Chandra, 4th Edn. TMH New Delhi.
4. Valence by C. A. Coulson.
5. Physical Chemistry by P. W. Atkins, ELBS London 1990.
6. Quantum Chemistry by Ira N. Levine, Prentiss Hall of India, New Delhi, India.
7. Quantum Chemistry by R. K. Prasad.
8. Electrochemistry by S. Glasstone.
9. Modern Electrochemistry by S. Bockris and A K N Reddy, Vol. 1 and 2, Butterworth London, 2006.
10. Thermodynamics by L. M. Koltz and R. M. Rosenberg.
11. An introduction to Chemical Thermodynamics by R. P. Rastogi and S. S. Mishra, Vikas publishing house Pvt limited, New Delhi.
12. Chemical Kinetics by K. J. Laidler, Pearson edition.
13. Polymer science by Gowrikar, New Age Pvt Limited publishers, Chennai.
14. Polymer chemistry by Flory.
15. Polymer chemistry by A. Tager.
16. Introduction to polymer chemistry Billmeyer(Jr)

HCP 1.3: PHYSICAL CHEMISTRY PRACTICAL - I

(64 Hours)

PART-I

1. Determination of rate constant and energy of activation of a first order reaction.
2. Comparison of acid strengths.
3. Determining adsorption isotherm.
4. Determination of Molecular weight of polymer by viscometer.

PART-II

1. Determination of dissociation of constant of a monobasic acid potentiometrically.
2. Determination of percentage composition of a given acid mixture conductometrically.
3. Determine the equivalent conductance of a strong electrolyte at several dilutions and hence verify the Onsagar's equation.
4. Determination of amount of CuSO_4 present in the given solution using Spectrophotometer.
5. Conductometric titration of a weak acid with weak base and a strong acid with weak base.

Books Recommended:

1. Frindeleys practical physical chemistry by B. P. Levitt.
2. Advanced practical physical chemistry by G. B. Yadhav.
3. Experiments in practical physical chemistry by Shomaker.
4. Systematic experimental physical chemistry by S. W. Rajbhoj and T. K. Chondeker.
5. Senior physical chemistry practicals by Khosla et. al.
6. Experiments in physical chemistry by Daniel alberty and Williams's et.al.

SCT 1.1: ANALYTICAL CHEMISTRY-I

Treatment of quantitative results, Gravimetry, Titrimetry, Ion exchange and Solvent extraction (64 Hours)

UNIT-I

Statistical Treatment of Analytical Data and Sampling: Limitations of analytical methods. Classification of errors-systematic errors-sources, effects and their reduction. Random errors-sources and distribution. Accuracy and precision. Measures of central tendency and variability. Reliability of results-confidence interval. Comparison of results-Student's t-test, comparing the two means and standard deviations: F-test, t-test and paired t-test. Rejection of a result Q-test. Number of replicate determinations. Control charts. Correlation and regression-correlation coefficient, linear regression, errors in slope and intercept, error in the estimate of concentration. Detection limits, sampling and sample handling-representative sample, sample storage, sample pretreatment and sample preparation. Hazards in sampling. Quality in analytical laboratories-quality control and quality assurance and accreditation system. [16 Hours]

UNIT-II

Gravimetric analysis: General principles, stoichiometry, calculation of results from gravimetric data. Properties of precipitates. Nucleation and crystal growth, factors influencing completion of precipitation. co-precipitation and post-precipitation, purification and washing of precipitates. Precipitation from homogeneous solution, a few common gravimetric determinations-chloride as silver chloride, sulphate as barium sulphate, aluminium as the oxinate and nickel as dimethyl glyoximate.

Acid base titrations: Principles of titrimetric analysis, titration curves for strong acid-strong base, weak acid-strong base and weak base-strong acid titrations, poly protic acids, poly equivalent bases, determining the equivalence point-theory of acid base indicators, colour change range of indicator, selection of proper indicator.

Applications of acid-base titrations: Determination of nitrogen, sulphur, ammonium salts, nitrates, and nitrites, carbonates and bicarbonates, and organic functional groups like carboxylic acid, sulphonic acid, amine, ester, hydroxyl, carboxyl groups, air pollutants like SO₂.

Acid-base titrations in non-aqueous solvents: Role of solvent in Acid-base titrations, solvent systems, differentiating ability of a solvent, some selected solvents, titrants and standards, titration curves, effect of water, determining the equivalence point, typical applications-determination of carboxylic acids, phenols and amines. [16 Hours]

UNIT-III

Precipitation titrations: Titration curves, feasibility of precipitation titrations, factors affecting shape-titrant and analyte concentration, completeness of the reaction, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the Fajan's methods, typical applications.

Complexometric titrations: Complex formation reactions, stability of complexes, stepwise formation constants, chelating agents, EDTA-acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, derivation of EDTA titration curves, effect of other complexing agents, factors affecting the shape of titration curves-completeness of reaction, indicators for EDTA titrations-theory of common indicators, titration methods employing EDTA-direct, back and displacement titrations. Indirect determinations,

titration of mixtures. Selectivity, masking and demasking agents, typical applications of EDTA titrations-hardness of water, magnesium and aluminum in antacids, magnesium, manganese and zinc in a mixture, titrations involving unidentate ligands-titration of chloride with Hg^{2+} and cyanide with Ag^+ . [16 Hours]

UNIT-IV

Ion Exchange methods: Introduction, Definitions, principle, cation exchangers, anion exchangers and their synthesis, regeneration, ion exchange columns used in chromatographic separation, selection of suitable systems, ion exchange capacity, ion exchange technique: Batch method, column method. Application of ion exchangers: separation of similar ion from one another, removal of interfering radicals, softening of hard water, complete demineralization of water, separation of lanthanides, separation of actinides, purification of organic compounds extracted in water, separation sugars, separation of amino acids, preparation of pure reagents, hydro metallurgy.

Solvent extraction: General discussion, principle, factors affecting solvent extraction, quantitative treatment of solvent extraction, synergistic extraction, ion association complex, extraction reagents: acetyl acetone, 8-hydroxy quinoline, Dimethyl glyoxime, 1-nitroso-2-naphthal, cupferron, dithiazole, sodium diethyl dithiocarbamate, ammonium pyrrolidinedithiocarbamate, tri-*n*-butylphosphate, poly (macrocylic) compounds, cetyltrimethyl ammonium bromide. Some practical considerations: choice of the solvent, extraction, stripping, completion of the analysis, automation of solvent extraction. Some applications: Determination of iron as 8-hydroxy quinolate, determination of lead by dithiazole method, determination of molybdenum by thiocyanate method. [16 Hours]

Books Recommended:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Instrumental Methods of Chemical Analysis, Chatwal and Anand - 5thEdn.
7. Chromatography, E. Heftman (ed). 5th Edition, Part A. and Part B. Elsevier Science Publishers, 1992.
8. Chromatography Today, C. F. Poole & S. K. Poole, Elsevier Science Publishers (1991).
9. Analytical chemistry by Alka L. Guptha, A pragathi edition.
10. Separation methods by M. N. Sastri, Himalaya publisher.
11. Modern analytical chemistry, Harvey, Harcourt publishers.
12. An introduction to chromatography, theory and practical, V. K Srivastav and K. K. Srivastav
13. Instrumental methods of chemical analysis, Gurudeep R Chatwal, Sharma K Anand. Himalaya publishers.
14. Chromatography by B. K. Sharma, GOEL publishers.
15. Basic concepts of Analytical chemistry, S. M. Khopakar, New Age International publications 3rd edition.

SCP 1.1 ANALYTICAL CHEMISTRY PRACTICAL-I

(64 Hours)

PART-I

1. Determination of total hardness of water.
2. Analysis of sodium carbonate and sodium bicarbonate in baking soda by acid-base titration.
3. Determination of acid content of vinegar.
4. Determination of magnesium and aluminum in antacid tablets by EDTA titrations.
5. Determination of chloride in solid samples by Mohr's method.
6. Estimation of Ni^{+2} as Ni-DMG.
7. Estimation of Al^{+3} as oxinate.

Books Recommended:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Experiment on water pollution, D. I. Williams and D. Anglesia, Wayland, Publishers Ltd, England, 1978.
7. Laboratory manual of organic chemistry by Raj K. Bansal. Wiley eastern limited.

SCT 1.2: PHARMACEUTICAL CHEMISTRY

(64 Hours)

UNIT-I

Cell Structure and Functions

Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolism process-catabolism and anabolism. ATP the biological energy currency; cyclic AMP; their biological significance. Origin of life-Unique properties of carbon, chemical evolution and rise of living system. Introduction of bio-macromolecules, building blocks of bio-macromolecules.

Pharmaceutical Microbiology

Isolation, cultivation, identification and classification of microorganisms, microorganism diseases, microbial ecology related to manufacturing process, disinfection, sterilization, preservation, microbial spoilage of formulated products, detection of microorganisms in raw materials and manufacturing items. [16 Hours]

UNIT-II

Drug Design– A Rational Approach

Introduction, concept of lead compound-crude drugs and analogues, factors governing drug design, rational approach to drug design, tailoring of drug. A brief introduction to quantitative structure activity relationship (QSAR), prodrug, combinatorial chemistry and computer aided drug design (CADD). Molecular modelling, Molecular mechanics, Molecular dynamics, Modelling of known and unknown receptors. [16 Hours]

UNIT-III

DRUG METABOLISM: Absorption, Distribution, Elimination, Dissolution of drugs and factors affecting these properties. Passage of drugs across biological membrane, Construction of diffusion equation for complex systems, Factors influencing drug metabolism and drug availability. Phase-I reaction – active and inactive metabolites and Phase-II reaction (Discuss Phase I & Phase-II reactions by taking examples from various categories of drug molecules).

PHARMACOKINETICS: Pharmacokinetics of one compartment and two compartment models, some applications of pharmacokinetics. Principle of multidosing, dose adjustment and bioavailability. Drug interactions-illustrate with examples. [16 Hours]

UNIT-IV

Industrial Pharmacy

Manufacturing, Quality control, Standard presentation, Labelling, Packing and Storage of formulations belonging to categories of Solid (Tablets and Capsules), Liquids (Syrup, Emulsions, Suspensions), Parental dosage forms, Acts and schedules in Pharmacy.

Introduction to Industrial Processing, Extraction: Methods of extraction, Continuous extraction. Distillation: Theory of distillation, azeotropic distillation, steam distillation, extractive distillation. Drying: Classification and types of dryers, factors affecting drying, tray dryer, freezer dryer, fluidized bed dryer, freezer dryer, spray dryer. [16 Hours]

Books Recommended:

1. Burger's Medicinal Chemistry, Ed, M. E. Wolff, Wiley-interscience.
2. Principles of Medicinal Chemistry, W.O.Foye, Varghese publishing house, Dadar, Mumbai.
3. Drug Design Dr. V. M. Kulkarni and Dr. K. G. Bothara, Nirali prakashan.
4. Wilson and Gisvold's Text book of Organic, Medicinal and Pharmaceutical Chemistry.
5. Principles of Bio-Chemistry, A. L. Lehninger, Worth publishers.
6. Medicinal Chemistry by Ashutosh kar, Wiley-Eastern Ltd.
7. Introduction to Drug Design- H. J. Smith and H. Williams.
8. Bentley's text book of Pharmaceutics-P. A. Rawling.
9. Pharmacological basis on therapeutics-Goodman and Gilman.
10. Industrial Pharmacy-Lachman.
11. Medicinal Chemistry by Hrikishan Singh.

SCP 1.2: PHARMACEUTICAL CHEMISTRY PRACTICAL

(64 Hours)

1. **Assays:** Aspirin, Paracetamol, Analgin, Ibuprofen, Chloroquin, Calcium gluconate, Pheneramine maleate, Suphadiazine, Ascorbic acid, Isonicotinic acid, Benzyl penicillin, Metronidazole, Dapsone.
2. **Preparation of Medicinally Important Compounds OR Intermediates Required for Synthesis of Drugs:**
 - a) Benzimidazole from o-phenylene diamine.
 - b) PABA from p-nitro benzoic acid
 - c) Sulphacetamide from Sulphanilamide
 - d) INH from Isonicotinic acid
 - e) Benzocaine
 - f) Coumarin derivatives
3. **Instrumental Methods for Estimation of the Following:**
 - a) Creatinine
 - b) Uric acid
 - c) Chloramphenicol
 - d) Cholesterol

Books Recommended:

1. Vogel's Text book of Practical Organic Chemistry
2. Commercial Methods of Analysis by F. D. Snell & B. M. Betteff
3. Medicinal Chemistry Vol-I, Vol-II & Vol-III by Burger
4. Indian Pharmacopoeia
5. British Pharmacopoeia

SEMESTER-II

HCT 2.1: INORGANIC CHEMISTRY – II

Non-transition and Transition Metal Chemistry, Metal Atom Clusters, Organometallic Chemistry

(64 Hours)

UNIT – I

Chemistry of Non-Transition Elements

Polymorphism of Carbon, Phosphorous and Sulfur, Synthesis, Properties and Structures of Boranes.; Carboranes and Metallocarboranes; Silicones, Phosphazones, Sulfur-nitrogen ring compounds; Peroxy acids of nitrogen, phosphorous, sulfur & halogens; Interhalogen compounds; Chemistry of noble gas compounds (Xenon fluorides). [16 Hours]

UNIT – II

Metal Atom Clusters:

Low valency and high valency clusters; low nuclearity (tri and tetra atomic) carbonyl clusters (LNCCs) and high nuclearity carbonyl clusters (HNCCs); Isoelectronic and Isolobal relationships; structural patterns of high nuclearity carbonyl clusters; Electron count schemes of HNCCs – Wade's rules; the capping rule; HNCCs of Fe, Ru and Os group, Co, Rh and Ir group, Ni Pd and Pt group; Octahedral metal halide and chalcogenide clusters; Chevrel phases; Compounds with metal-metal multiple bonds-Edge sharing,Face sharing bioctahedra; tetragonal prismatic and trigonal antiprismatic structures; Quadruple bond; One dimensional solids. [16 Hours]

UNIT – III

Reaction Mechanism of Transition Metal Complexes:

Energy profile of a reaction, reactivity of metal complexes, Inert and labile complexes. Substitution reactions in octahedral and square planar complexes and other complexes. Trans effect, mechanism of substitution reactions. Redox reactions, electron transfer reactions, mechanism of one electron, two electrons, complimentary & non-complimentary reactions, outer sphere and inner sphere type of reactions. [16 Hours]

UNIT – IV

Organometallic Chemistry:

18 electron and 16 electron rules; reactions of metal alkyls, aryls and olefin complexes. Reactions of organometallic complexes-substitution reactions, oxidative addition and reductive elimination reactions; insertion and elimination reactions.

Catalysis by Organometallic complexes: Alkene hydrogenation (Wilkinson's catalyst),; Hydroformylation; Water-Gas shift reaction; Monosanto acetic process; The Wacker process; Synthetic gasoline and Ziegler-Natta catalysis. [16 Hours]

Books Recommended:

1. Chemistry of Elements – N.N.Greenwood and Earnshaw - Pergamon
2. Concise Inorganic Chemistry - J.D. LEE, ELBS
3. Advanced Inorganic chemistry - F.A.Cotton and Wilkinson, John-Wily and sons
4. Chemistry of the Elements– N.N.Greenwood and A. Eamshaw, Pergaman
5. Inorganic Chemistry, Principles and Reactivity –J.E.Huheey, Harper and Row
6. Modern aspects of Inorganic Chemistry – H.J. Emuleus and A.G.Sharpe ELBS
7. Theoretical Inorganic Chemistry- M.C.Day, Jr. an J.Selbin East-West press
8. Concept and Model's in Inorganic Chemistry – Dougals, McDanial and Alexander John Wiley and sons.
9. Inorganic Qualitative Analysis- A.I.Vogel ELBS
10. Fundamentals of Analytical Chemistry- D.A.Skoog, D.M.West and F.T.Holler, Saunder college publishing
11. Inorganic Quantitative methods- Alexeev Mir publications
12. Principles of Inorganic Chemistry – Puri, Sharms and Kalia-Shobanlal-Nagin.
13. An Introduction to Inorganic Chemistry – Purcell and Kotz-Holt-Saunders
14. Coordination Chemistry-S.F.A. Kettle.
15. Comprehensive coordination Chemistry – G. Wilkinson, R.D. Gillars and J.A.Mcclevertry, Pergamon
16. Organometallic Chemistry – principles, structure and reactivity, 3rd ed. James E Huhee 1999.
17. Organgometallic Chemistry A Unified Approach - R.C.Mehrotra, A. Singh, New age international publishers
18. Organometallic compounds - Dr. Indrajeet kumar, pragathi prakashan

HCP 2.1: INORGANIC CHEMISTRY PRACTICAL-II

(64 Hours)

a) Quantitative Analysis:

Separation and Determination of two metal ions involving volumetric and gravimetric methods from the following

- i) Fe + Ni
- ii) Cu + Fe
- iii) Ca + Fe

b) Preparation of Complexes:

- i) Chloropentammine cobalt(III) chloride
- ii) Tris (acetylacetonate) copper (II) sulphate
- iii) Mercuric tetrathicyrato cobalate (II).

Books Recommended:

1. Vogel's Text book of Quantitative Inorganic Analysis – J.Basett, R.C.Denney, G.H.Jeffery and J.Mendhaman, Longmans Green and Company Ltd.
2. Practical Inorganic Chemistry-G.Pass and H.Sutchliff, Chpman and Hall Ltd. (1968).
3. General Chemistry Experiment- A.J.Elias, University press

HCT 2.2: ORGANIC CHEMISTRY– II

(64 Hours)

UNIT-1

Reaction Mechanism:

Aliphatic Electrophilic Substitutions: Bimolecular pathways. SE^2 , SE^1 and SE^i mechanisms. Reactions involving double bond shifts.

Aromatic Electrophilic Substitutions: Halogenation, Isotope effects, Energy profile diagrams. Kinetic and Thermodynamic control.

Aromatic Nucleophilic Substitutions: SN_{Ar} , $SN1$ and Aryne pathways. Meisenheimer complexes, Various Nucleophilic displacement.

Addition Reactions: Electrophilic addition across alkenes and dienes.

Substitution Reactions: Mannich Reactions, Chloromethylation and Vilsmeier-Haack reaction.

Elimination reactions: E_2 , E_1 , $E1C_B$ pathways, Stereochemistry, Hydrolysis of Esters, Mechanism: BA_{C2} and AA_{C2} . [16 Hours]

UNIT-II

Advanced Stereochemistry:

Prochirality: Homotopic, Enantiotopic and Diastereotopic atoms, groups and faces. Optical activity due to molecular dissymmetry: Allenes, Spiranes, Biphenyles, Atropisomerism, Molecular Crowding.

Conformational Analysis of Cyclohexane. Cis and Trans Decalins. 1,2 and 1,3 disubstituted Cyclohexane.

Stereo selective synthesis: Classification, terminology, Cram's rule (open chain, cyclic and chelet and dipolar models), Prolog's rule and principle of stereoselectivity. Strategy of stereoselective synthesis. Acyclic stereoselection. Enantioselective synthesis, diastereoselection in cyclic compounds. Catalytic hydrogenation, alkylation. Stereoselective formation of double bond, stereoselective cyclisation of polyenes. [16 Hours]

UNIT-III

Chemistry of Heterocycles:

Nomenclature, Structure, Reactivity, Synthesis and Chemical reactions of Indole, Quinoline, Isoquinolines, Pyrazole, Imidazole, Benzimidazole, α -Pyrone, γ -Pyrone, Coumarins, Chromones and Flavones. [16 Hours]

UNIT-IV

Oxidations, Reductions and Reagents:

Oxidations: Oxidations of Organic compounds using $KMnO_4$, OsO_4 , HIO_4 , SeO_2 , $Pb(OAc)_4$, and Oppenauer oxidation.

Reductions: Reductions of Organic compounds using the following reagents: $LiAlH_4$, $NaBH_4$, Carbonyl reduction. Birch reduction and Wolf-Kishner reduction.

Reagents: Methods of preparation, mechanism of reaction and applications of the following reagents in Organic synthesis.

a) DCC b) 1,3-Dithiane c) LDA d) DDQ e) Wilkinson catalyst f) Crown ethers g) Maryfield resins. [16 Hours]

Books Recommended:

1. Advanced Organic Chemistry Part A and B- F. A. Carey and R. J. Sundberg, 4th edition, Plenum publishers (2000).
2. Advanced Organic Chemistry, Reactions, Mechanism and Structure- J. March, Third Edition, Wiley-Eastern Ltd., (2004).
3. Guide Book to Mechanism in Organic Chemistry-Peter Sykes, Orient-Longman (1985).
4. Stereochemistry of Organic compounds, Principles and Applications- D. Nasipuri, Wiley Eastern Ltd. (1992).
5. Organic Chemistry Vol-II, III- S. M. Mukherji, S. P. Singh and R. P. Kapoor, New Age Internt, Ltd, New Delhi.
6. Organic Chemistry Vol-I, II- I. L. Finar, 6th Edition, ELBS London (2004).
7. Heterocyclic Chemistry- T. L. Gilchrist, 3rd Edition, Pearson Education Delhi, (2005).
8. Heterocyclic Chemistry- J. A. Joule and G. F. Smith, 2nd Edition, Van Nostrand London, (1978).
9. Heterocyclic Chemistry-R. K. Bansal, 3rd Edition, New-Age International, New Delhi, 2004.
10. Stereochemistry of Organic Cmpounds, E. L. Eliel et. Al John Wiley and sons Inc.

HCP 2.2: ORGANIC CHEMISTRY PRACTICAL-II

(64 Hours)

Qualitative analysis:

Separation of a binary mixture and identification of compounds containing two functional groups. (Any one with derivative)

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry revised- B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, 5th Edition, Addison Wesley Longman Limited, UK, 1997.
2. A Hand book of Organic Chemistry- H. T. Clarke.
3. A Laboratory Manual of Organic Chemistry- B. B. Dey and M. V. Govindachari.
4. Experimental Organic Chemistry- L. M. Harwood and C.J.Moody, Blackwell Scientific, London, 1989.
5. Practical Organic Chemistry – W. Kemp, McGraw Hill, London, 1962.

SCT 2.1 ANALYTICAL CHEMISTRY-II

Chromatography, Emission and Absorption spectroscopic Techniques (64 Hours)

UNIT-I

Basic Concepts of Chromatography: General description, definitions, terms and parameters used in chromatography Classification of chromatographic methods. Criteria for selection of a stationary and mobile phase-nature of adsorbents, factors influencing the adsorbents, nature and types of mobile phases.

Elution chromatography: Theories, rate theory. Band broadening, eddy diffusion, longitudinal diffusion and resistance to mass transfer. Column efficiency, plate theory and rate theory approach. Van Deemter's equation and its modern version. Inter relationship- capacity factor, selectivity factor and column resolution.

Thin layer Chromatography: Principle, methodology, determination of R_f value and its significance, variables that affect R_f value and applications. [16 Hours]

UNIT-II

Paper chromatography (PC): Definitions, theory and principle, techniques: one, two-dimensional and circular PC, mechanism of separation, structure of cellulose and types of paper, methodology-preparation of sample, choice of solvents, location of spots and measurement of R_f value, factors affecting R_f value, advantages and applications.

Gas chromatography (GC): Principle, comparison of GSC and GLC, instrumentation, columns-packed and tubular, study of detectors-thermal conductivity, flame ionization, electron capture and mass spectrometry, factors affecting separation, applications, GC-MS and its applications.

High pressure liquid chromatography (HPLC): Apparatus, pumps, column packing, characteristics of liquid chromatography detectors-UV, IR, refractometer and fluorescence detectors, advantages and applications, HPTLC and its applications.

Exclusion chromatography: Theory and principle of size exclusion chromatography, experimental techniques for gel-filtration chromatography (GFC) and gel-permeation chromatography (GPC), materials for packing-factors governing column efficiency, methodology and applications.

Affinity chromatography: Definitions, separation mechanism-matrices, matrix activation, role of spacer arms and applications [16 Hours]

UNIT-III

Ultracentrifugation: Principle, sedimentation constant, sedimentation equilibrium, sedimentation velocity, methodology and applications.

Electrophoresis: Overview, types, the basic of electrophoretic separations, migration rates and plate heights, electroosmotic flow, instrumentation, capillary zone electrophoresis, capillary gel electrophoresis, capillary isoelectrophoresis, capillary isoelectric focusing.

Capillary electrochromatography: Packed column electrochromatography, micellarelectrokinetic electrochromatography, capillary electro chromatography and applications.

Supercritical fluid chromatography: Properties of supercritical fluids, instrumentation and operating variables, comparison of supercritical to other types of chromatography, applications.

Supercritical fluid extraction: Advantages of supercritical fluid extraction, instrumentation, supercritical fluid choice, off-line and on-line extractions, typical application of supercritical fluid extraction. [16 Hours]

UNIT-IV

Flame photometry and Atomic absorption spectrometry: Energy level diagram – atomic absorption spectra. Flame characteristics, flame atomizers and electrothermal atomization. Comparison of spectral interferences, chemical and physical interferences in Flame Photometry and AAS. Use of organic solvents. Quantitative techniques – calibration curve procedure and the standard addition technique. Typical commercial instruments for Flame Photometry and AAS, Applications. Qualitative analysis and quantitative evaluations. Relative detectabilities of atomic absorption and flame emission spectrometry.

Inductively coupled plasma-Atomic emission spectroscopy: Limitations of flame emission spectroscopy, principles of plasma spectroscopy, process of atomisation and excitation, plasma as an excitation source, inductively coupled plasma source, ICP-AES instrumentation, applications of plasma spectroscopy, comparison of ICP-AES with AES, comparison of AFS, AAS and ICP-AES. [16 Hours]

Books Recommended:

1. Fundamental of Analytical Chemistry. D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry. G.D. Christian, 5th ed., 2001 John Wiley & sons, Inc, India
3. Quantitative analysis: R. A. Day and A. L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Text Book of quantitative chemical analysis, J. Mendham, R.C. Denney, J. D. Barnes and M. J. K. Thomas, 6th edition, Third Indian reprint 2003, Pearson education Pvt. Ltd., New Delhi.
5. Analytical chemistry principles, John H. Kennedy, 2nd edition, saunders college publishing, California, 1990.
6. Analytical chemistry, Alka. L. Gupta, A Pragati edition,
7. Introduction to chromatography, theory and practice by V. K. Srivastava and K. K. Srivastava., S. Chand and Co. Ltd.
8. Chromatography by B. K. Sharma, Goel publishing house, Meerut.
9. An introduction to practical biochemistry, 3rd edition by David T Plummer., Tata McGraw-Hill publishing company limited.
10. Principles of instrumental analysis, 5th edition, skoog, Holler and Nieman, Harcourt Asia PTE. LTD.
11. Modern analytical chemistry by David Harvey, McGraw-Hill publishing company limited.
12. Modern methods of chemical analysis, P. L. Descok, L. D. Shields, T. Carins and F. G. Milliam (II edn).
13. Industrial methods of chemical analysis, F. D. sneel (Encyclopedia)
14. Instrumental methods of analysis. L.L. Merutt, J.A. Dean, F.A., settle 6th Edn. (Van Nostnoand).
15. Principles of Instrumental Analysis. D.S. Kooj (Sander Colley).

16. Fundamentals of Analytical Chemistry. Skoog, West, Holler, 7th Edn. Harcourt Agra. Publication Harcourt College Publishers.
17. Principles of instrumental analysis. Skoog, Haller, Nieman, 5th Edn. Harcourt Agra. Publication Harcourt College Publishers.
18. Text Book of quantitative chemical analysis. A.I. Vogel (ELBS)
19. Standard Methods of chemical analysis. Wekin E. J.
20. Instrumental methods of chemical analysis, by Gurudeep R. Chatwal and Sham. K. Anand. Himalaya Publishing House.
21. Separation Chemistry. by R.P. Budhiraj, New age International(P) Limited, Publisher
22. Basic concepts of Analytical Chemistry, S.M. Khopkar, New age International(P) Limited, Publisher

SCP 2.1 ANALYTICAL CHEMISTRY PRACTICAL-II

(64 Hours)

1. Thin layer chromatographic separation of nitro anilines
2. Separation of metal ions of group IV by ascending chromatography.
3. Separation of metal ions of group I by ascending chromatography.
4. Separation of the components in the indicator by TLC/ Paper chromatography.
5. Separation of amino acids by paper chromatography.
6. Determination of Molybdenum by solvent extraction using KSCN as reagent.
7. Determination of iron by solvent extraction using 8-hydroxy quinoline as reagent.

Books Recommended:

1. Fundamental of Analytical Chemistry. D.A. Skoog, D. M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Vogel's Text Book of quantitative chemical analysis, J., Mendham, R.C. Denney, J. D. Barnes and M. J. K. Thomas, 6th edition, Third Indian reprint 2003, Pearson education Pvt. Ltd., New Delhi.
3. Introduction to chromatography, theory and practice by V. K. Srivastava and K. K. Srivastava., S. Chand and Co. Ltd.
4. Chromatography by B. K. Sharma, Goel publishing house, Meerut.

SCT 2.2: PHYSICAL CHEMISTRY-II

(64 Hours)

UNIT-I

Chemical Dynamics-2:

Chain reactions, Examples of chain reactions, General aspects of Chain reactions, elementary and complex reactions - parallel, consecutive and opposite reactions. Chain initiation, chain propagation and chain termination steps. Kinetics of formation of HBr, HI, HCl. Pyrolysis of acetylaldehyde, decomposition of ethane, ozone and N_2O_5 molecules. Kinetics of inhibition, chain transfer, kinetics of branching chain reaction and explosion limits.

Kinetics of polymerization: Kinetics of linear step(Condensation) polymerization, Kinetics of condensation polymerization, Free radical, cationic and anionic polymerization and Co-polymerization. [16 Hours]

UNIT-II

Diffraction Studies:

X-ray diffraction: Crystallographic systems, Space lattice, Reciprocal lattice, Bravais lattice, Unit cell, Weiss indices, Miller indices, Bragg's equation, Single crystal rotation methods, Powder methods, Structure factor and determination of molecular parameter. Fourier series, Fourier refinement. Phase problem.

Electron diffraction: Introduction, Scattering intensity versus scattering angle, Wierl's equation, Radial distribution function, Refinement radial distribution function, Rotation sector methods.

Neutron diffraction: Introduction, Scattering of neutrons by solids and liquids. Difference between neutron and X-ray diffraction. [16 Hours]

UNIT-III

Material chemistry and Nano materials:

Solid state reactions: general principles experimental procedures, co-precipitations as a precursor to solid state reactions, Preparation of crystalline and amorphous solids.

Ceramics: General aspects of electronic and magnetic ceramics, structure of spinels and garnets, high temperature super conductor, layer compounds. A brief discussion of thermal, electrical, dielectric, magnetic and optical properties of ceramic materials.

Composites: general characteristics and classification of composite materials. Dispersion strengthened composite materials. Fibre - reinforced composites. Nanocrystalline phase, preparation procedures, special properties and their applications.

Speciality solid materials (Fashionating solids): Aspects of material, fast ion conductor, storage material, organic material, Langmuir's Blodgett films, Liquid crystals, intercalation compounds (Graphite, dichalcogenides, transition metals). [16 Hours]

UNIT-IV

Atomic spectra and atomic structure:

Review of hydrogen spectrum, hydrogen like spectra. Atomic spectra of alkali and alkali like elements. Atomic spectra of helium, atomic spectra of alkaline earth and alkaline earth like elements, prohibition of inter combination, Mosely lines, Multiplet structure, simple and compound doublets and triplets. Space quantization, Stern-Gerlach experiment, Normal Zeeman effect, Anomalous Zeeman effect, Paschen Back effect, Stark effect. Comparison between Stark and zeeman effect

[16 Hours]

Books Recommended:

1. Physical Chemistry by P. W. Atkins.
2. Introduction to kinetics of chemical chain reactions by Gimblett (TMH).
3. Chemical kinetics by Laidler.
4. X-ray diffraction by Clug and Alexander.
5. Elements of X-ray diffraction by Cullity.
6. Determination of molecular structure by P. J. Wheatley.
7. An Introduction to X-ray Crystallography by M. M. Woolson.
8. Atomic structure and Atomic spectra by G. Herzberg.
9. Introduction to Atomic spectra by White.
10. Polymer science by Gowrikar.
11. Polymer chemistry by Flory.
12. Advanced polymer chemistry - A problem solving guide by Manas Chanda.
13. Physical Chemistry of macromolecules by D. D. Deshpande.

SCP 2.2: PHYSICAL CHEMISTRY PRACTICAL-II

(64 Hours)

PART-I

1. Determination of limiting equivalent conductance of a weak electrolyte.
2. Determination of Concentration of given solution by spectrophotometer (Cu^{2+} and NH_3).
3. Determination of optical rotation and rate constant by polarimeter.
4. Determination of standard electrode potential by potentiometry.
5. Determination of dissociation constant of dibasic acid potentiometrically.

PART-II

1. Determination of rate constant and order of reaction between $\text{K}_2\text{S}_2\text{O}_8$ and KI .
2. Determination of distribution coefficient for benzene, benzoic acid and water system.
3. Construction of phase diagram for three component system.
4. Determine the equilibrium constant for the reaction $\text{KI} + \text{I}_2 = \text{KI}_3$ by distribution method.
5. Determination of molecular weight of a given solute by Beckmann thermometer.

Books Recommended:

1. Frindeleys Practical physical chemistry by B. P. Levitt.
2. Advanced practical physical chemistry by G. B. Yadhav.
3. Experiments in practical physical chemistry by Shomaker.
4. Systematic experimental physical chemistry by S.W. Rajbhoj and T K Chondeker.
5. Senior physical chemistry practicals by Khosla et. al.

OET 2.1: CHEMISTRY-I (Analytical Chemistry)

Treatment of quantitative results, Gravimetry, Titrimetry and Basic concepts of chromatography (64 Hours)

UNIT-I

Statistical Treatment of Analytical Data and Sampling: Limitations of analytical methods. Classification of errors-systematic errors-sources, effects and their reduction. Random errors-sources and distribution. Accuracy and precision. Measures of central tendency and variability. Reliability of results-confidence interval. Comparison of results-Student's t-test, comparing the two means and standard deviations F-test, t-test and paired t-test. Rejection of a result, Q-test. Number of replicate determinations. Control charts. Correlation and regression-correlation coefficient, linear regression, errors in slope and intercept, error in the estimate of concentration. Detection limits, Sampling and sample handling-representative sample, sample storage, sample pretreatment and sample preparation. Hazards in sampling. Quality in analytical laboratories-quality control and quality assurance, accreditation system. [16 Hours]

UNIT-II

Gravimetric analysis: General principles, stoichiometry, calculation of results from gravimetric data. Properties of precipitates. Nucleation and crystal growth, factors influencing completion of precipitation. Co-precipitation and post-precipitation, purification and washing of precipitates. Precipitation from homogeneous solution, a few common gravimetric determinations-chloride as silver chloride, sulphate as barium sulphate, aluminium as the oxinate and nickel as dimethyl glyoximate.

Acid base titrations: Principles of titrimetric analysis, titration curves for strong acid-strong base, weak acid-strong base and weak base-strong acid titrations, poly protic acids, poly equivalent bases, determining the equivalence point-theory of acid base indicators, colour change range of indicator, selection of proper indicator.

Applications of acid-base titrations: Determination of nitrogen, sulphur, ammonium salts, nitrates, and nitrites, carbonates and bicarbonates, and organic functional groups like carboxylic acid, sulphonic acid, amine, ester, hydroxyl, carboxyl groups, air pollutants like SO₂.

Acid-base titrations in non-aqueous solvents: Role of solvent in Acid-base titrations, solvent systems, differentiating ability of a solvent, some selected solvents, titrants and standards, titration curves, effect of water, determining the equivalence point, typical applications-determination of carboxylic acids, phenols and amines. [16 Hours]

UNIT-III

Precipitation titrations: Titration curves, feasibility of precipitation titrations, factors affecting shape-titrant and analyte concentration, completeness of the reaction, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the Fajan's methods, typical applications.

Complexometric titrations: Complex formation reactions, stability of complexes, stepwise formation constants, chelating agents, EDTA-acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, derivation of EDTA titration curves, effect of other complexing agents, factors affecting the shape of titration curves-

completeness of reaction, indicators for EDTA titrations-theory of common indicators, titration methods employing EDTA-direct, back and displacement titrations. Indirect determinations, titration of mixtures, selectivity, masking and demasking agents, typical applications of EDTA titrations-hardness of water, magnesium and aluminum in antacids, magnesium, manganese and zinc in a mixture, titrations involving unidentate ligands-titration of chloride with Hg^{2+} and cyanide with Ag^+ . [16 Hours]

UNIT-IV

Basic Concepts of Chromatography: General description, definitions, terms and parameters used in chromatography Classification of chromatographic methods. Criteria for selection of a stationary and mobile phase-nature of adsorbents, factors influencing the adsorbents, nature and types of mobile phases.

Elution chromatography: Theories, rate theory. Band broadening eddy diffusion, longitudinal diffusion and resistance to mass transfer. Column efficiency, plate theory and rate theory approach. Van Deemter's equation and its modern version. Inter relationship- capacity factor, selectivity factor and column resolution.

Thin layer Chromatography: Principle, methodology, determination of R_f value and its significance, variables that affect R_f value and applications. [16 Hours]

Books Recommended:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Instrumental Methods of Chemical Analysis, Chatwal and Anand - 5thEdn.
7. Chromatography, E. Heftman (ed). 5th Edition, Part A. and Part B. Elsevier Science Publishers, 1992.
8. Chromatography Today, C. F. Poole & S. K. Poole, Elsevier Science Publishers (1991).
9. Analytical chemistry by Alka L. Guptha, A pragathi edition.
10. Separation methods by M. N. Sastri, Himalaya publisher.
11. Modern analytical chemistry, Harvey, Harcourt publishers.
12. An introduction to chromatography, theory and practical, V. K Srivastav and K. K. Srivastav
13. Instrumental methods of chemical analysis, Gurudeep R Chatwal, Sharma K Anand. Himalaya publishers.
14. Chromatography by B. K. Sharma, GOEL publishers.
15. Basic concepts of Analytical chemistry, S. M. Khopakar, New Age International publications 3rd edition.

OEP 2.1: CHEMISTRY PRACTICAL-I (Analytical Chemistry) (64 Hours)

PART-I

1. Determination of total hardness of water.
2. Analysis of sodium carbonate and sodium bicarbonate in baking soda by acid-base titration.
3. Determination of acid content of vinegar.
4. Determination of magnesium and aluminum in antacid tablets by EDTA titrations.
5. Determination of chloride in solid samples by Mohr's method.
6. Estimation of Ni^{+2} as Ni-DMG.
7. Estimation of Al^{+3} as oxinate.

Books Recommended:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Experiment on water pollution, D. I. Williams and D. Anglesia, Wayland, Publishers Ltd, England, 1978.
7. Chromatography by B. K. Sharma, GOEL publishers.
8. Laboratory manual of organic chemistry by Raj K. Bansal. Wiley eastern limited.

OET 2.2: CHEMISTRY-II (Physical Chemistry)

(64 Hours)

UNIT - I

Quantum Chemistry:

A brief review of black body radiation, Photoelectric effect, Compton effect, de-Broglie's hypothesis, Heisenberg's uncertainty principle., Concept of operator - Addition, Subtraction, Multiplication of operators, Commutative, Linear, Del, Hermitian operators and their properties , Hamiltonian operators, eigen values and Eigen function. Postulates of quantum mechanics Schrödinger wave equation - wave function and its interpretation, elementary application to a particle in one dimensional box, particle in a ring and hydrogen atom. One dimensional harmonic oscillator

Conditions for orthogonality and normalization of wave functions Kroneckers delta. Criteria for the formation of atomic and molecular orbitals: Paulies exclusion principle. Concept of σ , σ^* , π , π^* orbitals with characteristics. Hybrid orbitals. Comparison of M.O and V B. [16 Hours]

UNIT - II

Electrochemistry and Thermodynamics:

Activity and Activity co-efficient, Mean activity co-efficient, Debye-Huckle limiting law (qualitative aspect only) and assumptions. Ionic strength, thickness of ionic atmosphere. Basic concept of acids and bases, pH, pKa, pKw. Buffer action and capacity. Buffer solutions. Handerson Hassalback equation and its application in preparation of buffer. Importance of buffer in biological system.

Brief resume of concepts of laws of thermodynamics. Free energy, chemical potential and entropy. Gibb's-Helmholtz equation, Gibb's-Duhem and Maxwell's relation. Fugacity and its variation and determination of Duhem-Margulus Equation and its application to thermodynamics of ideal and non-ideal solutions. [16 Hours]

UNIT - III

Polymer Chemistry:

Review of polymers, Basic concepts and classification of polymers - Monomer, Repeat units, Linear, Branched, Cross Linked, Straight, Copolymers and Networks and interpenetrating networks(IPN). Degree of polymerization. Molecular weight distribution - Average molecular weight concepts, Number Average, Weight Average, Viscosity Average and Z - Average molecular weights. Determination of molecular weights, Osmotic pressure method, viscosity method, light scattering (Debye and Zimm plots), Ultra centrifugation method, Polydispersity and molecular weight distribution, Practical significance of polymer molecular weight, Glass transition temperature (T_g) and Melting point and relation between them. Commercial importance of polymers. Size of Polymer molecules. [16 Hours]

UNIT - IV

Chemical Dynamics-1:

A brief review of basic concepts and terminology in reaction kinetics. Methods of determining rate laws. Steady state approximation, Arrhenius equation. Collision state theory for bimolecular reaction rates, Transition state theory. Comparison between collision and transition state theories. Lindemann and RRKM theories of unimolecular reaction rates. Concepts and significance of energy of activation.

Dynamics in solution: Ionic reactions, effect of ionic strength. Primary and secondary salt effects. Dynamics of Fast reactions, Relaxation methods, Flow methods (stopped flow and plugged flow), Flash photolysis methods. **[16 Hours]**

Books Recommended:

1. Molecular Quantum Chemistry P.W Atkins
2. Problems in Quantum Mechanics by G. L. Squires.
3. Introduction to Quantum Chemistry by A. K. Chandra, 4th Edn. TMH New Delhi.
4. Valence by C. A. Coulson.
5. Physical Chemistry by P. W. Atkins, ELBS London 1990.
6. Quantum Chemistry by Ira N. Levine, Prentiss Hall of India, New Delhi, India.
7. Quantum Chemistry by R. K. Prasad.
8. Electrochemistry by S. Glasstone.
9. Modern Electrochemistry by S. Bockris and A K N Reddy, Vol. 1 and 2, Butterworth London, 2006.
10. Thermodynamics by L. M. Koltz and R. M. Rosenberg.
11. An introduction to Chemical Thermodynamics by R. P. Rastogi and S. S. Mishra, Vikas publishing house Pvt limited, New Delhi.
12. Chemical Kinetics by K. J. Laidler, Pearson edition.
13. Polymer science by Gowrikar, New Age Pvt Limited publishers, Chennai.
14. Polymer chemistry by Flory.
15. Polymer chemistry by A. Tager.
16. Introduction to polymer chemistry Billmayer(Jr)

OEP 2.2: CHEMISTRY PRACTICAL – II (Physical Chemistry) **(64 Hours)**

PART-I

1. Determination of rate constant and energy of activation of a first order reaction.
2. Comparison of acid strengths.
3. Determining adsorption isotherm.
4. Determination of Molecular weight of polymer by viscometer.

PART-II

1. Determination of dissociation constant of a monobasic acid potentiometrically.
2. Determination of percentage composition of a given acid mixture conductometrically.
3. Determine the equivalent conductance of a strong electrolyte at several dilutions and hence verify the Onsager's equation.
4. Determination of amount of CuSO_4 present in the given solution using Spectrophotometer.
5. Conductometric titration of a weak acid with weak base and a strong acid with weak base.

Books Recommended:

1. Frindeleys practical physical chemistry by B. P. Levitt.
2. Advanced practical physical chemistry by G. B. Yadhav.
3. Experiments in practical physical chemistry by Shomaker.
4. Systematic experimental physical chemistry by S. W. Rajbhoj and T. K. Chondeker.
5. Senior physical chemistry practicals by Khosla et. al.
6. Experiments in physical chemistry by Daniel alberty and Williams's et.al.

SEMESTER-III
HCT 3.1: ORGANIC CHEMISTRY– III (Spectroscopy)
(64 Hours)

UNIT-I

Electronic, Chiroptical and Vibrational Spectroscopy:

Introduction, energy considerations, experimental methods, Beer-Lambert's law. Theory and classification of electronic transitions. Terminology, substituent and solvent effects. Woodward-Fieser rules and their application in structural elucidation of organic compounds.

UV spectral study of alkenes, dienes, polyenes. Carbonyl and aromatic compounds. Steric effects, isobetic points, model compounds and charge transfer bands.

Vibrational Spectroscopy: Introduction and experimental methods. Units, notation and regions. Dispersive and FT-IR sampling techniques Complementarity of IR and Raman. Fundamental vibrations, Overtones, group frequencies, factors affecting group frequencies; Conjugation, Inductive, Resonance, steric effects. Mechanical coupling, Fermi resonance. Applications of IR In the study of H-bonding, stereoisomerism, tautomerism. Identification of the following organic compounds by IR; Alkenes, Alkynes, Aromatic compounds, Aldehydes, Ketones, Alcohols, Thiols, Acids, Acid chlorides, Amides, Amines, Esters, Halides and Nitro compounds.

[16 Hours]

UNIT – II

Proton Magnetic Resonance Spectroscopy:

Introduction- Magnetic properties of nucleus, Resonance condition, Field frequency Diagram, Precession of nuclei, Relaxation – CW and PFT methods. Instrumentation and sample handling, chemical shift- Mechanism of shielding and deshielding in alkanes, alkenes, alkyl halides, aromatic compounds, carbonyl compounds and annulenes. Chemical shifts of different types of organic compounds- Empirical rules. Spin-spin coupling, geminal and vicinal coupling. Relative intensities, Karplus equation-curve, equivalence of protons-chemical and magnetic equivalence. Spin-spin splitting system- First order and second order patterns.

Long range coupling- Spin decoupling, CIDNP, NOE, Lanthanide shift reagents. Protons attached to elements other than carbon exchange phenomena and temperature effect. **[16 Hours]**

UNIT – III

Multi-Nuclear NMR and correlation spectroscopy:

¹³C-NMR Broad band and off resonance decoupling, methods of detection.

¹³C chemical shifts of different classes of organic compounds- Alkanes, alkyl halides, alkenes, alcohols, ethers, carbonyl compounds and aromatic compounds.

¹³C-H coupling DEPT. Introductory aspects of ¹⁵N, ¹⁹F, ³¹P-NMR. Correlation NMR spectroscopy.

Theory, pulse sequence. FT methods ¹H-¹H (Cosy) and ¹³C-H (Heterocopy) methods. **[16 Hours]**

UNIT-IV

Mass Spectroscopy and Composite Problems:

Ionization and mass analysis:

Instrumentation, methods of ionization, EI, CI, DI, SI-methods.

Fragmentation: Principle, odd and even electron ions, molecular ion and base peak, nitrogen rule, meta stable ions, Isotopic effect in chloro and bromo compounds. Stevenson rule.

Fragmentation of:

i) Normal and branched alkanes, ii) Alkenes iii) benzene and its derivatives iv) Alcohols
v) Aldehydes vi) Ketones vii) Acids viii) Esters ix) Ethers x) Amines xi) Nitro compounds xii)
Halo compounds xiii) Peptides.

Mc Lafferty and Mc Lafferty+1 rearrangement, calculation of molecular formula. Composite problems.

Applications of UV, IR, NMR, and MS methods and chemical reactions in structure elucidation of organic compounds. **[16 Hours]**

Books Recommended:

1. Introduction to spectroscopy- By D. L. Paxia, G. M. Lampman and G. S. Kriz.
2. Spectroscopic identification of Organic compounds by R. M. Silverstein and F. X. Webster, 6th edn, Wiley and Sons, India Ltd (2006).
3. Organic spectroscopy- by William Kemp, 3rd edn. Palgrave Publishers (2002).
4. Organic Structural spectroscopy- by J. B. Lambert, H. F. Shurvell, D. A. Lightner and R. G. Cooks. Prentice Hall Publishers, Jersey (1998).
5. Organic spectroscopy- by D. W. Brown, A. J. Floyd and M. Sainsbury, John Wiley and sons.
6. Applications of Absorption Spectroscopy of Organic compounds-by J. R. Dyer, Prentice Hall Publishers, New Delhi (1969).
7. Interpretation of mass spectroscopy- by Mc Lafferty.
8. Organic spectroscopy- V. R. Dani, Tata McGraw Hill Ltd (1995).
9. Spectroscopic of Organic compounds- by P. S. Kalsi, 4th edn, New Delhi (2005).
10. Organic spectroscopy- by Jag Mohar (Narosa Publishing House) (2001).
11. Organic spectroscopy- by Yadav.

HCP 3.1: ORGANIC CHEMISTRY PRACTICAL-III

(64 Hours)

Synthesis / Spectral Analysis

Books Recommended:

1. Applications of computers in chemistry- Raman.
2. Computers and their applications to chemistry- Ramesh Kumar, Narosa Publishing House (2002).
3. Laboratory experiments in organic chemistry – Arun Sethi, New Age International ltd. New Delhi (2006).
4. A Hand book of Organic chemistry – H. T. Clarke.
5. Vogel's text book of practical organic chemistry, revised 5th edn, Addison Wesley, Longman Ltd, UK (1997).

HCT 3.2: PHYSICAL CHEMISTRY-III

(64 Hours)

UNIT-I

Statistical Thermodynamics and Quantum Statistics: Macrostates and Microstates, Assemblies of localized and Non-localized systems, Phase space, γ -Space, μ -Space, and Ensembles.

Classical Statistics: Maxwell-Boltzman distribution law for ideal gases and mixture of gases equipartition of energies, Maxwell-Boltzman distribution of velocities and energies (no derivation).

Quantum Statistics: Relationships between probabilities and entropy, Sterling approximation. Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann Statistics and comparison between them. Heat capacity of Ortho-Para hydrogen systems. Einstein's heat capacity for solids.

Partition Function: Definition and separation of partition functions. Translational, Vibrational, Rotational and Electronic partition functions for Monoatomic, Diatomic, and Polyatomic gaseous molecules. Sackur-Tetrode equation. Calculation of thermodynamic quantities in terms of partition functions, Comparison of third law of entropy with statistical entropy and residual entropy. [16 Hours]

UNIT-II

Quantum Chemistry: Review of concepts of operators. Applications of Schrödinger wave equation to Hydrogen like atoms, rigid Rotor, Harmonic oscillators and Hartree Self consistent field theory.

Approximation Methods-Variation theory and Perturbation theory (zero, first, second order).

MO Theory: MO Theory of Hydrogen molecule and ion, Energy levels of H_2^+ , Bonding and Anti-bonding orbitals. Examples of MO of simple HOMO and HETERO nuclear molecules. Notations of few molecular orbitals, correlation diagrams and Non-crossing rules, Simple Huckel theory of linear conjugated systems (HMO) and applications to systems like ethylene, butadiene etc.

VB Theory: Secular equation, Determinants, Columbic, exchange and overlap integrals. VB theory of H_2 molecule, Comparison of VB and MO theories. [16 Hours]

UNIT-III

Solid State Chemistry: Solid state reactions: General principles and classification of reactions and thermal methods of investigation of solid state reactions.

Crystal defects: Perfect and imperfect crystals, intrinsic and extrinsic defects, point defect, plane defect, vacancies defect, Schottky defects and Frankel defects, non stoichiometric defect, meises defect, electronic properties of solids.

Band theories of solids: Conductors, semiconductors and insulators. Fermi energy levels, magnetic properties of solids- Ferro, Ferri, Para and anti-ferromagnetism (Qualitative treatment only). Magnetic hysteresis.

Optical properties: Optical reflectance, photo conduction and photoelectric effect. Thermal, and electric properties of solids. [16 Hours]

UNIT-IV

Thermodynamics, Non-equilibrium Thermodynamics and Surface Colloids: Solutions: Introduction, Gibb's function of mixing and other thermodynamic mixing functions, chemical potential of liquids and liquid mixtures, Excess function for non-ideal solutions.

Non-equilibrium Thermodynamics: Microscopic reversibility, entropy production in irreversible process. Different types of forces and fluxes, stationary states phenomenological equations. Onsagar's reciprocity relations, Principle of minimum entropy production, phenomenological in non-linear region.

Surface Colloids: Preparation and purification of colloids, stability & degree of salvation. Electro kinetic phenomena of colloids, Classification of Surface active agents, Critical Micellar concentration (CMC), Thermodynamics of Micellization, Determination of Surface tension by 'Surface Tension Method'. **[16 Hours]**

Books Recommended:

1. Theoretical Chemistry- Glasstone.
2. Statistical Mechanics- Davidson.
3. Elements of Statistical Thermodynamics- E. K. Nash
4. Statistical Thermodynamics- M.C.Gupta
5. Introduction to Quantum Chemistry- A.K.Chandra
6. Quantum Chemistry- R.K.Prasad
7. Textbook of Quantum Mechanics-P M Mthews & P Venkateshan
8. Problems in Quantum Mechanics- G.L.Squiras.
9. Introduction to Solids- I. V. Azarrof.
10. Solid State Chemistry- A.R.west
11. Modern aspects of Solid State Chemistry- Ed. By C.N.Rao
12. New direction in Solid State Chemistry- C.N.Rao & Gopal Krishnan
13. Thermodynamics by L.M. Koltz & R.M. Rosenberg
14. Thermodynamics by Glasstone
15. Physical Chemistry by P.W. Atkins.
16. Molecular Quantum Chemistry by A. J. Atkins.

HCP 3.2: PHYSICAL CHEMISTRY PRACTICALS-III (64 Hours)

Part-I

1. Effect of added salt (Uni-Uni and Bi-Bi salts)
2. Determination of rate constant and order of reaction between $K_2S_2O_8$ and KI.
3. Determination of equilibrium constant of reaction between $KI + I_2 = KI_3$ by distribution method.
4. Kinetic study of iodination of an acetone.
5. Study of kinetics of inversion of cane sugar by Polarimetry.
6. Phase diagram of three component system.

Part-II

1. Titration of p-Toludine against HCl by conductometry.
2. Determination of end point of some typical titrations. (Precipitation & replacement) conductometrically.
3. Potentiometric titration of o-phosphoric acid against alkalies NaOH.
4. Potentiometric titration of halide mixture against $AgNO_3$.
5. Titration of mixture of HCl, AcOH, $CuSO_4$ against conductometrically
6. Determination of equivalent conductance at infinite dilution of a strong electrolyte and verification of Onsgars law.
7. Potentiometric titration of $Pb(NO_3)_2$ vs EDTA
8. Potentiometric titration of mixture of weak acids, HCOOH, CH₃COOH, ClCH₂COOH Vs NaOH Estimation of metal ions solution by plarographic method.
9. Determination of surface tension.

Note: the number of practical may be modified depending upon the facilities and requirements.

Books Recommended:

1. Frindeleys Practical Physical Chemistry- B.P.levitt.
2. Advanced Practical Physical Chemistry- G.B.Yadav
3. Experiments Practical Physical Chemistry- Shomaker
4. Systematic experimental Physical Chemistry- S.W.Rajbhoj & T.K.Chondeker
5. Senior Physical Chemistry Practical- Kholosa et.al

SCT 3.1: ANALYTICAL CHEMISTRY-III

Environmental chemistry and Analysis of complex materials (64 Hours)

UNIT - I

Air pollution, analysis and control: Historical overview-global implications of air pollution, sources of pollutants, classification pollutants. Sources and effects of particulates, carbon monoxide, sulphur oxides, nitrogen oxides, hydrocarbons and photochemical oxidants on human health, vegetation and materials. Standards for air pollutants.

Air quality monitoring: Sampling methods and devices for particulates and gaseous pollutants. SO₂: ambient air measurements and stack gas measurements-Turbidimetric, colorimetric, conductometric and coulometric methods. NO_x: Griess-ilosvay and Jacobs-Hockheiser colorimetric methods, chemiluminiscent technique. CO: NDIR, amperometric, FID and catalytic oxidation methods. Hydrocarbons: total and individual hydrocarbons by gas chromatography. Oxidants and ozone: colorimetric, coulometric, titrimetric, and chemiluminescence methods.

Air Pollution control: Atmospheric cleaning processes, approaches to contaminant control-detection and control at source.

Control devices for particulates: Gravitational settlers, centrifugal collectors, wet collectors, electrostatic precipitation and fabric filtration.

Control devices for gaseous pollutants: Adsorption, absorption, condensation and combustion processes. Automotive emission control-catalytic converters. [16 Hours]

UNIT – II

Water pollution and analysis: Water resources, origin of wastewater, types of water pollutants of their sources and effects, chemical analysis for water pollution control-objectives of analysis, parameters of analysis, sample collection and preservation. Environmental and public health significance and measurement of color, turbidity, total solids, acidity, alkalinity, hardness, chloride, residual chlorine, chlorine demand, sulphate, fluoride, phosphates and different forms of nitrogen in natural and in waste/polluted waters, heavy metal pollution-public health significance of Pb, Cd, Cr, Hg, As, Cu, Zn and Mn, general survey of the instrumental techniques for the analysis of heavy metals in aquatic systems, organic loadings-significance and measurement of DO, BOD, COD, TOD, and TOC, phenols, pesticides, surfactants, tannin and lignin as water pollutants and their determination. [16 Hours]

UNIT-III

Waste water treatment: waste water characteristics, effluent standards, terminology in waste water treatment. Treatment of domestic waste water-preliminary treatment.

Primary treatment: sedimentation, equalization, neutralization.

Secondary treatment: Aerated lagoons, trickling filters, activated sludge process, oxidation ditch, oxidation pond and anaerobic digestion. Sludge treatment and disposal.

Tertiary treatment: evaporation, ion-exchange, adsorption, electro dialysis, electrolytic recovery and reverse osmosis.

Advanced waste water treatment: Nutrient removal-nitrogen and phosphorus removal, solid removal.

Waste water disposal and reuse. Industrial waste water and its treatment (paper and pulp, sugar and leather industries)

Soil Analysis: Inorganic and organic components of soil, collection and preparation of soil samples for analysis. Measurement of soil pH and conductivity. Determination of organic carbon, total nitrogen, available nitrogen, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen. Available phosphorus and sulphur, their determination. Analysis of soil for sodium, potassium, calcium and magnesium. Micronutrient elements and their analysis. Pesticide residues in soil, their separation and determination, soil pollution and control. **[16 Hours]**

UNIT-IV

Analysis of Complex Materials: Composition, Properties and Analysis of:

Minerals and Ores: Hematite, pyrolusite, dolomite, chromate, bauxite and limestone,

Metal and Alloys analysis: Steel, Cu-Ni alloy, solder, bronze, brass and aluminum alloy.

Analysis of structural materials: Cement.

Fuel Analysis: Definition and classification of fuels, characteristics of fuels, sampling, proximate and ultimate analysis of coal, and determination of calorific value. Liquid fuels: determination flash point, fire point, aniline point, knocking of petrol and diesel octane and cetenennumbers, carbon residue. Gaseous fuels-analysis of coal gas, water gas, producer gas, gobar gas and blast furnace gas. Calorific value, determination of Junker's gas calorimeter. Relative merits of solid, liquid and gaseous fuels. **[16 Hours]**

Books Recommended:

1. Standard Methods of chemical Analysis. A. J. Welcher (part B), Robert E. Krieger Publishing Co. USA, 1975.
2. Environmental Chemistry.S. E. Manahan, Willard grants press, London, 1983.
3. Environmental Chemical Analysis.Iain L Marr and Malcolm s. Cresses, Blackie and Son, Ltd, London, 1983.
4. Chemistry for environmental engineering.Chair N. Sawyer and Perry L. M Canty, McGraw Hill Book, Co., New York 1975.
5. The Air Pollution Hand Book.RichardMabey, Penguin, 1978.
6. The Pollution Hand Book.RichardMabey, Penguin 1978.
7. Soil Chemical Analysis.M. L. Jackson, Prentice Hall of India Pvt, Ltd., New Delhi, 1973.
8. Experiments in environmental chemistry.P. D. Vowler, and D.W. Counel, Pergamon press, Oxford 1980.
9. Manual Soil Laboratory Testing Vol-I. K. H. Head, Pentech Press, London 1980.
10. A Text Book of Environmental Chemistry and Pollution Control.S. S. Dara, S. Chand and Co. Ltd. New Delhi 2004.
11. Instrumental Methods for automatic air monitoring systems in Air Pollution Control Part-III edn, by W.Stranss, John-wiley and sons, New York, 1978.
12. Air pollution Vol-II.edn. A.C. Stern, Academic Press New York, 1968.
13. Analysis of Air Pollutants.P. O. Warner, John Wiley and sons, New York, 1976.

14. The Chemical Analysis Air pollutants, Interscience. New York, 1960
15. The Analysis of air pollutants. W. Liethe, Ann Arbor Science Pub. Inc. Michigan 1970.
16. Environmental Chemistry. A. K. De. New Age International (P) Limited, Publishers
17. Laboratory Manual for Environmental Chemistry. Sunita Hooda and Sumanjeet Kaur, S. Chand & Company Ltd.
18. Environmental Pollution Analysis. S. M. Khopkar, New Age International (P) Limited, Publishers.
19. An Introduction to Air Pollution. P. K. Trivedi and P. K. Goel, Techno science Publications, Jaipur (Ind).
20. Practical Ecology. K. S. Rao, Anmol Publications Pvt. Ltd, New Delhi.
21. Encyclopedia of industrial methods of chemical analysis. F. D. Snell (All Senus)
22. Qualitative inorganic analysis by A. I. Vogel.
23. Chemical analysis of terms and nonferrous and foundry materials. Westword and Mayar.
24. Chemical methods of analysis. Snell and Snell
25. A text book of inorganic analysis. A. I. Vogel.
26. Laboratory manual for Environmental chemistry. Sunita Hooda & Sumanjeet Kaur.
27. Analytical Chemistry. Dr. ALKA L. GUPTA apragati edition.
28. Applied Chemistry theory and practice second edition. O. P. Vermani. A. K. Narula

SCP 3.1: ANALYTICAL CHEMISTRY PRACTICAL-III (64 Hours)

PART-A

1. Analysis of solder.
2. Analysis of copper nickel alloy.
3. Analysis of hematite.
4. Determination of phosphorous by spectrophotometry.
5. Determination of COD of water.
6. Determination of pH of soil.
7. Determination of Total dissolved salts and conductivity of water.

Books Recommended:

1. Standard Methods of chemical Analysis. J. Welcher (part B), Robert E. Krieger Publishing Co. USA, 1975
2. A text book of inorganic analysis. A. I. Vogel.
3. Chemical methods of analysis. Snell and Snell.
4. Practical Ecology. K. S. Rao, Anmol Publications Pvt. Ltd, New Delhi.
5. Laboratory manual for Environmental chemistry. Sunita Hooda & Sumanjeet Kaur.

SCT 3.2 INORGANIC CHEMISTRY-III

(64 Hours)

Industrial, Bioinorganic, Nuclear and Photochemistry

UNIT- I

Industrial Chemistry: Introduction, physical and chemical properties, raw materials, methods of manufacturing, types and uses with respect to cement, ceramics, glass, iron and steel and alloys.

Industrial Pollution: Industrial pollution with respect to cement, thermal power plants and metallurgy, disposal of waste and its management, Nuclear waste management including waste storage and disposal procedures. [16 Hours]

UNIT-II

Bio-inorganic Chemistry: Essential and trace metals, chlorophyll and its role in photosynthesis; transport and storage of dioxygen-heme proteins; oxygen uptake--functions of haemoglobin, myoglobin, hemerythrin and hemocyanins, synthetic oxygen carriers. Metal storage and transport, ferritin, transferrin and ceruloplasmin. Electron transfer proteins--cytochromes and iron-sulphur proteins; Biological nitrogen fixation; in vivo and in vitro nitrogen fixation, interactions of transition metal complexes.

Chemical Toxicology: Toxic chemicals in the environment; impact of toxic chemicals on enzymes; biochemical effect of As, Cd, Pb, Hg, CO, NO_x, SO₂, ozone and PAN, Cyanide, pesticides and carcinogens. [16 Hours]

UNIT-III

Nuclear and Radio Chemistry: Fundamentals; units of radioactivity; interaction of α , β and γ radiation with matter; Determination of half life period, radioactive decay, kinetics, parent-daughter decay-growth relationships; Detection and measurement of radioactivity; construction and operation of ionization chambers; G.M. counters and scintillators; Induced radioactivity, nuclear fission and fusion.

Nuclear Reactors: Characteristics features, nuclear reactors in actual use; some Indian reactors, applications of reactors--advantages and disadvantages of nuclear reactors, power reactors; Nuclear power stations in India, An introduction to breeder reactors. Applications of nuclear sciences. [16 Hours]

UNIT-IV

Photoinorganic Chemistry: Absorption, excitation, photochemical laws, quantum yield, electronically excited states, life times measurements for the times; Energy dissipation by radiative and non-radiative process; Excited states of metal complexes; Comparison with organic complexes, charge transfer spectra, charge transfer excitations; Photo substitution reactions, photo oxidation and photo reduction reactions; photo isomerisation and photo recimization reactions; metal complexes as sensitizers. [16 Hours]

Books Recommended:

1. Fundamentals of Photochemistry - Rohatgi Mukherjee.
2. Photochemistry of co-ordination compounds - V. Balzarli and V. Carassitt (Academic Press).
3. Industrial Chemistry - B.K. Sharma (Goel Publishers).
4. Industrial Chemistry - Rogers (Wiley, Vol. I&II).
5. Environmental Chemistry - 4th Edition A.K. Dey (New Age International Publisher, 2001).
6. Test Book of Environmental Chemistry - O.D. Tyagi and M.Mehra (Anmol Publications).
7. Environmental Pollution Analysis - S.M. Khopkar (Wiley Eastern).
8. Principles of Instrumental Analysis - Skoog, Hollar and Nieman (Harcourt Asia Pvt ltd., India New Delhi 5th Edition, 1998).
9. Instrumental Methods of Chemical Analysis – Chatwal and Anand (5th Edition).
10. Instrumental Methods of Chemical Analysis - H. Kaur.
11. Essentials of Nuclear Chemistry- H.J. Arnikar (Wiley Eastern, 1987).
12. Radiation Chemistry: An Overview – D.B.Naik and S. Dhanya (BARC, Mumbai).
13. Nuclear and Radiation Chemistry- B. K Sharma, 7th Edition 2011.
14. Fundamentals of radiochemistry-D.D.Sood, A.V.R.Redyy,N.Ramamoorthy.

SCP 3.2 INORGANIC CHEMISTRY PRACTICALS – III

(64 Hours)

PART – A

1. Analysis of cement.
2. Analysis of dolomite ore.
3. Analysis of steel.
4. Analysis of copper- nickel in alloy/mixture.
5. Analysis of hematite ore

PART - B

1. Separation and estimation of aluminium and magnesium by 8-hydroxy quinoline reagent.
2. Separation and estimation of nickel and copper by salicyaldoxime reagent.
3. Separation and estimation of cations by using anion exchanger.
4. Separation and estimation of anions by using cation exchanger.
5. Determine the amount of molybdenum in the given solution by solvent extraction.

Books Recommended:

1. Vogel's Text Book of Quantitative Inorganic Analysis- J. Basett, R. C. Denney, H. Jeffery and J. Mendham, Longmans, Green and company Ltd.
2. Practical Inorganic Chemistry-G. Pass and H. Sutcliff, Chapman and Hall Ltd. (1968).
3. General Chemistry Experiments-A. J. Elias, University Press.

OET 3.1: CHEMISTRY –III (Inorganic Chemistry)

Bonding, Bioinorganic, Stereochemistry and Acid-base theory (64 Hours)

UNIT – I

Ionic bonding: Properties of ionic compounds, lattice energy, Born-Land's equation, Born-Haber cycle and its applications, Kapustinskii equation, Solvation energy, dissolution of ionic compounds in polar solvents and their energetics. The predictive power of thermochemical calculations of ionic compounds, covalent character in ionic compounds. Radius ratio and structure of ionic compounds and efficiency of packing of crystal lattices.

Covalent bonding: Valence bond theory, orbital overlap, molecular orbital theory, symmetry and overlap, molecular orbital diagrams of diatomic molecules (homo- and hetero- nuclear), triatomic molecules, linear (CO_2 , N_2O) and angular (NO_2), Walsh diagrams, Bent rules, some reactions of covalently bonded molecules, Resonance, hybridization, VSEPR theory, molecular geometries. [16 Hours]

UNIT – II

An over view of metals in biology: Introduction; the element content of living systems; biological chemistry of hydrogen; the economical use of resources—abundance and availability; biological need and behavior of inorganic elements.

Sodium and potassium channels and pumps: Introduction; transport across membranes; potassium and sodium channels; the sodium and potassium pump; active transport driven by Na^+ gradients, sodium/proton exchangers; other roles of intracellular K^+ .

Metal assimilation pathways: Introduction; metal assimilation in bacteria, plants, fungi and in mammals (iron, copper and zinc).

Storage and homeostasis of metal ions: Introduction; metal storage and homeostasis in bacteria, plants, fungi and in mammals (iron, copper and zinc). [16 Hours]

UNIT – III

Stereochemistry of Coordination Compounds: Coordination geometry, types of isomerism (geometrical & optical). Review of bonding theories; Molecular orbital theory/Ligand field theory (octahedral, tetrahedral and square planar complexes), MO theory applied to complexes with π -bonding. Evidences for metal-ligand orbital overlap, spectrochemical series and Jahn-Teller distortion in coordination compounds.

Magnetism: Types of magnetism; magnetic susceptibility; spin only moment; orbital contribution to spin only moment. [16 Hours]

UNIT – IV

Review of Acid-Base Concepts: Introduction, different definitions, types of reactions, solvent system and leveling effect. Generalized Acid-Base concepts (basicity of metal oxide, hydration and hydrolysis).

Measurement of Acid-Base strengths, Steric effect (back strain, front strain and Internal strain) Solvation effects with reference to liquid ammonia, anhydrous sulfuric acid, acetic acid and liquid sulfur dioxide. Hard-Soft Acids and Bases; classification, strength of hardness and softness; Irving William series; theoretical basis of hardness and softness. [16 Hours]

Books Recommended:

1. Advanced Inorganic chemistry - F.A.Cotton and Wilkinson, John-Wily and sons
2. Chemistry of the Elements - N.N.Greenwood and A. Eamshaw, Pergamon
3. Concise Inorganic Chemistry - J.D. LEE, ELBS
4. Inorganic Chemistry, Principles and Reactivity -J.E.Huheey, Harper and Row
5. Modern aspects of Inorganic Chemistry - H.J. Emuleus and A.G.Sharpe ELBS
6. Theoretical Inorganic Chemistry - M.C.Day, Jr. an J.Selbin East-West press
7. Concept and Model's in Inorganic Chemistry - Dougals, McDanial and Alexander John Wiley and sons.
8. Inorganic Qualitative Analysis - A.I.Vogel ELBS
9. Fundamentals of Analytical Chemistry - D.A.Skoog, D.M.West and F.T.Holler, Saunder college publishing
10. Inorganic Quantitative methods - Alexeev Mir publications
11. Principles of Inorganic Chemistry - Puri, Sharms and Kalia-Shobanlal-Nagin.
12. An Introduction to Inorganic Chemistry - Purcell and Kotz-Holt-Saunders
13. Coordination Chemistry-S.F.A. Kettle.
14. Comprehensive coordination Chemistry - G. Wilkinson, R.D. Gillars and J.A.Mcclevertry, Pergamon

OEP 3.1: CHEMISTRY PRACTICAL-III

(64 Hours)

Part-A

Semimicro qualitative inorganic analysis of a mixture.

Mixture containing three cations and three anions including one less common cations such Mo, Ti, Zr, Ce, V and Li and one interfering anion.

Part-B

- i) Determination total hardness of water.
- ii) Determination of nickel by complexometry (by back titrations)

Books Recommended:

1. Chemical Semi micro analysis- V.N.Alexeyev Mir Publishers (Mascow)
2. Vogel's Qualitative Inorganic analysis, Revised by G.Suchla Longarman group ltd.
3. Vogel's Text book of Quantitative Inorganic Analysis - J.Basett, R.C.Denney, G.H.Jeffery and J.Mendhaman, Longamans Green and Company Ltd.

OET 3.2: CHEMISTRY-IV (Organic Chemistry)

(64 Hours)

UNIT-I

Bonding and Aromaticity:

Hybridization, bond length, bond angle, bond energies, bond polarity and dipole moment aromaticity and Huckels rule-HMO theory, Non-benzonoid aromatics, Annulenes (10-18).

[16 Hours]

UNIT-II

Stereochemistry:

Elements of symmetry, symmetry operations E/Z, R/S nomenclature, Fischer, Sawhorse, Newmann projection, Enantiomers, Diastereomers and Epimers.

Prochirality: Homotopic, enantiotopic, diastereotopic groups.

[16 Hours]

UNIT-III

Organic Reactions:

Reactivity, classification of organic reactions, methods of identification kinetics, non kinetic methods. Isotopic labeling techniques, intermediates, cross over products and product proportions in different types of reactions. Named reactions. Classification, Aldol, Dieckmann, Claisen-Schmidt and similar anion addition reactions.

[16 Hours]

UNIT-IV

Heterocycles and Group Transformations:

Structure, synthesis, reactivity of the following heterocycles and their biologically important derivatives. pyrrole, furan, thiophene, pyridine, pyrimidine, Quinoline, isoquinoline & indole. Organic functional group inter conversions involving substitution, addition, eliminations, oxidation, reductions, esterification and hydrolytic reactions.

[16 Hours]

Books Recommended:

1. Organic Chemistry-P. Y. Bruice, Pearson education pvt. Ltd, New Delhi (2002).
2. Organic Chemistry- S. H. Pine, McGraw Hill, London (1987).
3. Organic Chemistry- R. T. Morrison, R. J. Boyd, Prentice Hall, New Delhi (1994).
4. Organic Chemistry-T. W. Graham Solman 4th edn, John Wiley & Sons (1988).
5. Organic Chemistry- Vol. I & II, I. L. Finar, 6th Edn. ELBS, London (2004).
6. Organic Chemistry- F. A. Carey, 4th edn, McGraw Hill (2000).
7. Advanced Organic Chemistry Reaction Mechanism and Structure- J. March, 4th edn. Wiley Eastern Ltd. (2004).
8. Stereochemistry- Conformation and Mechanism, P. S. Kalsi, Wiley-Eastern Ltd., New Delhi (1992).
9. Heterocyclic Chemistry- T. L. Gilchrist, Butterworth, London (1985).
10. Heterocyclic Chemistry- J. A. Joule & G. F. Smith, 2nd edn, Van Nostrand, London (1978).

OEP 3.2: CHEMISTRY PRACTICAL-IV (Organic Chemistry) **(64 Hours)**

Synthesis and Polarimetry:

1. Benzoic acid and Benzyl alcohol from Benzaldehyde (Cannizaro Reaction).
2. P-Nitroaniline from Acetanilide.
3. P-Bromoaniline from Acetanilide.
4. Methyl Orange.
5. Benzil from Benzaldehyde.
6. Benzanilide from Benzophenone (Beckman Rearrangement).
7. Aniline from Benzene.
8. 2,4-Dinitrophenol from Chlorobenzene.
9. M-Nitroaniline from Nitrobenzene.
10. Benzoic acid from Toluene.

Quantitative estimation of sugar, mixture of sugars and determination of specific rotation of sugars

Books recommended:

1. Laboratory experiments in organic chemistry – Arun sethi, New Age International Ltd. New Delhi (2006).
2. A Hand book of organic chemistry- H. T. Clarke.
3. Vogel's text book of practical organic chemistry, revised 5th edn, Addison Wesley, Longman Ltd, UK (1997).

SEMESTER - IV

HCT 4.1: INORGANIC CHEMISTRY – IV

(64 Hours)

Metal - ligand equilibria, Electronic, Mossbauer, NQR, ESR and Photoelectron spectra

UNIT-I

Metal-Ligand Equilibria in Solution: Kinetic and thermodynamic stability, lability and inertness. Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to nature of metal and ligand, chelate effect.

Determination of stability constants and stoichiometry by spectrophotometric, potentiometric, P^H and polarographic methods. Calculations of ΔG° , ΔH° and ΔS° from overall stability constants.

[16 Hours]

UNIT-II

Electronic Spectra of Transition Metal Complexes: Free ion terms and energy levels; configurations, Terms, States and Microstates; calculation of microstates for p^2 and d^2 configurations; L-S (Russel and Saunders) coupling schemes, J-J coupling scheme, derivation of terms for p^2 and d^2 configurations; Hole formulation, energy ordering of terms (Hund's Rules); Selections rules—Laporte orbital selection rule, spin selection rule; splitting of energy level and spectroscopic states; Orgel diagrams of d^1 to d^9 metal complexes; interpretation of electronic spectra of aqua complexes of Ti (III), V (III), Cr (III), Mn (II), Fe (II), Fe (III), Co (II), Ni (II) and Cu (II); calculation of Racah parameters (B and C) for d^8 metal complexes; Tanabe-Sugano diagrams for d^2 and d^6 octahedral complexes; Charge transfer spectra of metal complexes.

[16 Hours]

UNIT-III

Mossbauer Spectroscopy: Basic principle, spectral parameters, spectral display. Doppler effect, Zeeman splittings, isomer shift, Quadrupole splitting, magnetic interaction. Mossbauer spectrometers, components.

Applications of Mossbauer techniques to the studies of (i) Bonding and Structure of Fe^{+2} and Fe^{+3} compounds (ii) Detection of oxidation states.

NQR Spectroscopy: Consequence of nuclear spin larger than $\frac{1}{2}$, prolate and oblate nucleus, nuclear quadrupolar charge distribution-theory and instrumentation, relationship between electric field gradients and molecular structure, applications and interaction of eQq data. Effect of crystal lattice on the magnitude of eQq. Structural information from NQR spectra.

[16 Hours]

UNIT-IV

Electron Spin Resonance Spectroscopy: Basic principles, zero field splitting, Kramer's degeneracy, factors affecting g-values. Interpretation of g-values. Isotopic and anisotropic hyperfine coupling constants. Spin Hamiltonian, spin densities and Mc Connel relationship. Measurement techniques.

ESR spin – orbit coupling and significance of g tensors application to first row transition metal complexes.

Photoelectron Spectroscopy: Basic principles, photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, chemical information from ESCA, instrumentation and applications. Auger electron spectroscopy principles, instrumentation and applications. **[16 Hours]**

Books Recommended:

1. Advanced Inorganic Chemistry - F.A. Cotton and G. Wilkinson (John Wiley).
2. Inorganic Chemistry - J. Huheey, Harper and Rao.
3. Principles of Instrumental Analysis - Skoog, Hollar and Nieman (Harcourt Asia Pvt ltd., India New Delhi 5th Edition, 1998).
4. Instrumental Methods of Chemical Analysis – Chatwal and Anand (5th Edition).
5. Organic Chemistry – Wiliam Kemp (3rd Edition ELBS 1991).
6. Organic Spectroscopy – P.S. Kalasi (Tata Mc. Graw Hill 1993).
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry – R.V. Parish, Ellis Horwood.
8. Instrumental Method of Analysis – Willard, Mserit and Dean.
9. Instrumental Methods of Chemical Analysis –B.K.Sharma(Goel publishing house Meerut, 2000) .
10. Introduction to Spectroscopy- Pavia, Lampman and Kriz.
11. Strctural Methods in Inorganic Chemistry – E.A. Ebsworth,D.W.H.Ranbin and S.Cradock, ELBS.
12. Instrumental Methods of Chemical Analysis - H. Kaur.

HCP 4.1: INORGANIC CHEMISTRY PRACTICALS-IV

(64 Hours)

PART- A

1. Estimation of aluminium as aluminiumoxinate.
2. Estimation of magnesium as magnesium oxinate.
3. Estimation of nickel as nickelsalicylaldoximate.
4. Preparation of triaxolato ferrate (III) sodium complex.

PART – B

- 1 Determiration of iron using o-phenanthroline as a reagent by spectrophotometry.
- 2 Determiration of zirconium using alizarin red s as a reagent by spectrophotometry.
- 3 Determine the composition of complex of copper ethylenediamine by spectrophotometry .
- 4 Determiration of iron by potentiometrically.
- 5 Determiration of suphate by conductometrically.
- 6 Determiration of halides by potentiometrically.

Books Recommended:

1. Vogel's Text Book of Quantitative Inorganic Analysis- J. Basett, R. C. Denney, H. Jeffery and J. Mendham, Longmans, Green and company Ltd.
2. Practical Inorganic Chemistry-G. Pass and H. Sutcliffe, Chapman and Hall Ltd.(1968).
3. General Chemistry Experiments-A. J. Elias, University Press.

HCT 4.2: PHYSICAL CHEMISTRY-IV

(64 Hours)

UNIT-I

Electrochemistry and Photochemistry:

Ion-solvent interaction, Born model, solvation number and their determination, over voltage, Decomposition potential, Butler-Volmer equation, Tafel equation, Factors important in elucidating electrode reaction and some electrochemical systems of technological importance, Electroplating.

Electrochemical energy systems: Introduction, fundamentals of batteries, primary and secondary batteries, fuel cells, types of fuel cells,

Interaction of radiation with matter, review of laws of photochemistry, Jablonski's diagram, radiative and non-radiative processes. Stern – Volmer equation, photophysical kinetics of uni and bimolecular processes. Photolysis of water. Theories of Fluorescence, Phosphorescence and Bioluminescence. [16 Hours]

UNIT-II

Catalysis and Group Theory:

Adsorption, adsorption isotherms- Langmuir, Freundlich, BET and Gibb's adsorption isotherms, adsorption with dissociation, competitive adsorption, mechanism of Unimolecular and bimolecular surface reactions.

Homogenous catalysis: Principle of general and specific acid-base catalysis, linear free energy relation and acidity function, salt effect and base catalysis.

Heterogeneous catalysis: Study of solid surface, employing surface techniques viz. BET and N₂ adsorption.

Enzyme catalysis: single substrate mechanism, Michaelis-Menten equation, effect of pH, temperature and inhibition on kinetics of enzyme catalyzed reaction.

Group Theory: Symmetry operators and symmetry elements, products of symmetry operations C_{2v}, C_{3v}, C_{2h}, groups, point groups, group multiplication table, character table, matrix representation of groups, reducible and irreducible representations. [16 Hours]

UNIT-III

Molecular Spectroscopy:

Characterization of electromagnetic radiation, quantization of energy levels, rotational spectroscopy, classification of molecules based on their moment of inertia, rotation of rigid diatomic molecules and non rigid diatomic molecules and rotational energy levels.

Infrared Spectra: Vibration of diatomic molecule, simple harmonic oscillator model, vibrational energy levels and vibrational spectra, The anharmonic oscillator model, fundamental bands, overtones and hot bands.

Vibrational and rotational spectra of diatomic and polyatomic molecules and its applications to CO, CO₂ and H₂O molecules. Overtones and combination frequencies PQR branches, Born-Oppenheimer approximation.

Electronic spectra of diatomic molecules, Electron transition in diatomic molecule V⁺ and V⁺ progressions. Deslander's table, Frank-Condon principle, rotational fine structure of electronic vibrations Fortrate diagrams and pre dissociation.

Raman Spectroscopy: Introduction, Stokes and anti-Stokes lines, classical and quantum theory of Raman Effect, Raman activity of vibration, rotational and vibrational Raman spectra, mutual exclusion principle, Resonance Raman Spectroscopy. [16 Hours]

UNIT-IV

Polymer Science and Technology:

General introduction to polymers, molecular weight distribution, fractionation, molecular weight distribution curves, determination of molecular weight by end group analysis and GPC method, determination of chain dimension from light scattering technique, understanding of thermo mechanical behavior, thermal behavior of polymers from TMA and DMA techniques, physical properties v/s applications, plastic, fibers, elastomers, and additives, kinetics of chain polymerization, types of polymerization, linear step polymerization, radical polymerization, ionic polymerization- cationic and anionic polymerization, ring opening polymerization and copolymerization. Swelling of polymers, stress strain behavior, viscoelastic behavior and elastomers. [16 Hours]

Books Recommended:

1. Modern aspects of electrochemistry Vol-I & Vol-II- J.O.M.Bockris & A.K.N Reddy
2. Electrochemistry by Glasstone
3. Heterogeneous catalysis- G.C.Bond
4. The basic applications of heterogeneous catalysis- Michael Bowker.
5. Fundamentals of Molecular Spectroscopy- CN Banwell & Mc Cash
6. Introduction to molecular Spectroscopy- G.M.barrow
7. Polymer Chemistry- Billayer
8. Polymer Chemistry- P.J.Flory
9. Physical chemistry of macromolecules by D.D.Deshpande
10. Polymer Science- Gowarikar
11. Physical chemistry- P.W. Atkins
12. Chemical Kinetics- Laidler

HCP 4.2: PHYSICAL CHEMISTRY PRACTICALS-IV (64 Hours)

Part-I

1. Determination of stability constant of the complex formed between Fe^{3+} and Salicylic acid-5-SSA.
2. Determination of pKa of given indicator.
3. Determination of specific and molar rotation of optically active substances and to find out the intrinsic rotation.
4. Determination of surface tension of liquid by stalagnometer.
5. Determination of molecular weight of given polymer(Polyvinyl alcohol, polystyrene, methyl acrylate etc) using viscometer.
6. Determination of Ka values of given samples by pH-metric titration.

Part-II

1. Titration of mixture of KCl and KI against AgNO_3 by conductometry.
2. Titration of o-phosphoric acid against NaOH by pH meter.
3. Determination of solubility of sparingly soluble salt by Potentiometry.
4. Kinetics saponification of ethyl acetate by conductometry.
5. Kinetics of decomposition of benzene diazonium chloride and determination E_a and Thermodynamic parameters
6. Determination of ionic product of water and study of effect of temperature.
7. Elucidation of structure from the given spectroscopic data.

Note: the number of practical may be modified depending upon the facilities and requirements.

Books Recommended:

1. Frindeleys Practical Physical Chemistry- B.P.levitt.
2. Advanced Practical Physical Chemistry- G.B.Yadav
3. Experiments Practical Physical Chemistry- Shomaker
4. Systematic experimental Physical Chemistry- S.W.Rajbhoj & T.K.Chondeker
5. Senior Physical Chemistry Practical- Kholsa et.al

SCT 4.1: ANALYTICAL CHEMISTRY-IV

Automation methods, Biomedical & Food analysis, Radioanalytical and Thermal methods (64 Hours)

UNIT-I

Automated systems: An overview, definition, distinction between automatic and automated systems, advantages and disadvantages by automation, types of automated techniques. Non-discrete techniques, segmented flow methods and basic equipment, special techniques and devices, theoretical considerations and problems, applications. Single/channel and multi-channel auto analysers, BUN analysers, automatic glucose analyser and ammonia in water analyser, COD analyser, CFA in industry. Non-segmented flow methods: Flow injection analysis, principles, types of dispersions, factors affecting dispersion, applications of small, medium and large dispersions, stopped flow methods, flow injection titrations. Discrete methods: Centrifugal fast scan analyser, automatic multipurpose analysers, automatic elemental analyser, automated analyser based on multilayer film-principles, film structure, instrumentation and applications. Comparison of discrete and non-discrete methods. Advantages of flow injection measurements over continuous flow measurements. [16 Hours]

UNIT-II

Body fluids: Composition and detection of abnormal level of certain constituents leading to diagnosis, sample collection and preservation of physiological fluids, analytical methods for the constituents of physiological fluids (blood, urine).

Blood: Estimation of glucose, cholesterol, urea, haemoglobin and bilirubin.

Urine: Urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.

Enzymes: Biological significance, analysis and assay of enzymes (pepsin, tyrosinase), vitamins (thiamine, ascorbic acid, vitamin A) and hormones (progesterone, oxytocin, insulin), chemical, instrumental and biological assay to be discussed wherever necessary.

Forensic analysis: General discussion of poisons with special references to mode of action of cyanide, organophosphates and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological materials. [16 Hours]

UNIT III

Pharmaceutical analysis: Identity and purity requirements, standard operating procedures (SOP) for the assay of tablets.

Preformulation studies. Solid-dosage form analysis. Analytical testing for finished parental products. Analysis of common drugs: Aspirin, paracetamol. Vitamins- B₁, B₂, B₆, niacin and folic acid. Antibiotics – penicillin and chloramphenicol.

Food Analysis: Historical perspectives, objectives of food analysis. Sampling procedures. General methods for the determination of moisture, crude fibre and ash contents of foods. Analysis of foods for minerals-phosphorus, sodium, potassium and calcium. Food additives. Chemical preservatives-inorganic preservatives-sulphur dioxide and sulphites, their detection and determination. Organic preservatives-benzoic acid and benzoates, their detection and determination. Pesticide residues in foods. [16 Hours]

UNIT IV

Radioanalytical Methods:

Radioactive tracers, principles and applications. Isotopic dilution analysis – direct and inverse; special analytical applications and radiometric titrations.

Neutron activation analysis: Principle, instrumentation, applications and limitations.

Radiochromatography and radio immunoassay- principle and applications.

Thermal methods: Thermogravimetry- instrumentation, factors affecting thermogram, applications.

Differential thermal analysis (DTA) - theories, apparatus, and applications.

Differential scanning calorimetry (DSC) – Introduction, instrumentation and applications.

Thermometric titrations and applications. **[16 Hours]**

Books Recommended:

1. Pharmaceutical Analysis. T. Higuchi and E. B. Hanssen, John Wiley and Sons, New York.
2. Quantitative Analysis of drugs.P.D.Sethi, 3rd edition. CBS Publishers, New Delhi, 1997.
3. Practical Clinical biochemistry methods and interpretations. R. Chawla, J.P.Brothers Medical Publishers (P), 1995.
4. Laboratory manual in biochemistry. J. Jayaraman, New Age International Publishers, New Delhi, 1981.
5. Pharmaceutical Analysis. Modern methods – Part A and B, Edited by James W. Munson.
6. Hawk's physiological chemistry. Edited by B.L.Oser, 14thedn, Tata McGraw Hill, (1976).
7. The Essentials Forensic Medicine and Toxicology.Dr. K. S. Narayana Reddy.
8. Practical clinical Biochemistry. Harold Varley and Arnold, Heinmann, 4thedn.
9. Analysis of Foods. H. E. Cox.
10. Chemical Analysis of Foods. H. E. Cox and Pearson.
11. Handbook of Modern Pharmaceutical Analysis.Vol.3, Eds. S. Ahuja and S. Scypinski, Academic Press, Tokyo, 2001.
12. A First Course in Food Analysis. A.Y Sathe, New Age International (P) Limited, Publishers.
13. Methods in Food Analysis 2ndedn. Edited by Mayanard A. Joslyn, Academic Press.
14. Fundamental of Analytical Chemistry. D.A.Skoog, D.M.West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
15. Analytical Chemistry. G.D. Christian, 5thedn, 2001 John Wiley & Sons, Inc, India.
16. Pearson's Composition and Analysis of Foods, 9thedn, Ronald S. Kirk, Ronald Sawyer, Addison- Wesley An imprint of Addison Wesley Longman, Inc.
17. The Chemical Analysis of Foods and Food products. 3rdedn.Morris B. Jacobs, Robert E. Krieger publishing co.inc.
18. Food Analysis, Theory and Practice, 3rdedn.YeshajahuPomeranz and Clifton E. Meloan, CBS Publishers & Distributors, New Delhi
19. The Quantitative Analysis of Drugs, 3rdedn. D. C. Garratt, science Paperbacks
20. British Pharmacopeia Vol. I & II.
21. Instrumental methods of analysis. L. L. Meritt, J. A. Dean, F.A., settle 6thEdn. (Van Nostnoand).

22. Principles of Instrumental Analysis. D. S. Kooj (Sander Colley).
23. Fundamentals of Analytical Chemistry. Skoog, West, Holler, 7thEdn. Harcourt Agra. Publication Harcourt College Publishers.
24. Principles of instrumental analysis. Skoog, Haller, Nieman, 5thEdn. Harcourt Agra. Publication Harcourt College Publishers.
25. Treatise an analytical chemistry. F. J. Kohthiff& F. T. Elhiy, (M. Interscience).
26. Nuclear and Radiochemistry. G. Dridelandey, J. M. Millar, M. M. Keondy& E. S. Macias (John Willey).
27. Essentials of Nuclear Chemistry. H. J. Arnikar (Wiley Eastern)
28. Text Book of quantitative chemical analysis. A.I. Vogel (ELBS)
29. Standard Methods of chemical analysis. Wekin E. J

SCP 4.1: ANALYTICAL CHEMISTRY PRACTICAL-IV

(64 Hrs)

PART-A

1. Determination of uric acid in urine.
2. Determination of cholesterol in blood.
3. Analysis of APC tablet.
4. Analysis of paracetamol.
5. Determination of Vitamin-C in tomato.
6. Determination of Iron in mustard seeds.
7. Determination of phosphorus in peas.
8. Determination of ash & moisture content in food.

Books Recommended:

1. Quantitative Analysis of drugs. P.D.Sethi, 3rd edition. CBS Publishers, New Delhi, 1997.
2. The Quantitative Analysis of Drugs, 3rdedn. D. C. Garratt, science Paperbacks.
3. A First Course in Food Analysis. A.Y Sathe, New Age International (P) Limited, Publishers.
4. The Chemical Analysis of Foods and Food products. 3rdedn.Morris B. Jacobs, Robert E. Krieger publishing co.inc.
5. British Pharmacopeia Vol. I & II.

SCT 4.2: SPECIAL TOPICS IN ORGANIC CHEMISTRY

(64 Hours)

UNIT-I

Photochemistry: Activation of thermal and photochemical reactions. Light absorption and excitation, singlet and triplet states. Morse curves, Franck-Condon principle. De excitation processes, Jablonski diagram, photosensitization (donor, acceptor concept, resonance, collision and transfer). Chemical processes, quantum yield and quantum efficiencies. Variation in singlet and triplet states. Phenomena of optical pumping, Remote functionalization (Barton reaction).

Photochemistry of olefins: Cis-trans isomerisation, (2+2) cycloaddition and rearrangements. Reactions of conjugated olefins and di- π methane rearrangements.

Photochemistry of Ketones: Excited states of ketones, Norrish type -I and type -II cleavages. Pattero-Buchi reaction, α,β -unsaturated ketones, (2+2) addition, cis-trans isomerization. Rearrangements of cyclohexadienones.

Photochemistry of aromatic Compounds: Photorearrangement of benzene and its derivatives, cycloaddition of benzenes and substitutions of benzene derivatives.

Photochemical oxidation and reduction: Cycloadditions of (singlet) molecular oxygen, oxidative coupling, photoreduction by hydrogen abstraction. [16 Hours]

UNIT-II

Pericyclic reactions: Definition of various terms, Pericyclic, electrocyclic, cycloaddition, sigmatropic, chelotropic and ene reaction. Con-rotatory, disrotatory, suprafacial, antarafacial, HOMO, LUMO etc.

Symmetry properties of molecular orbitals of ethylene, butadiene, hexatriene, vinyl radicals, anion, cation, pentadienyl radical, anion and cation. Conservation of orbital symmetry and the photochemical concerted processes. Formulation of selection rule by 1) orbital correlation diagrams 2) HOMO-LUMO method and 3) Huckel-Mobius aromaticity approach (all qualitative method only) for electrocyclic reactions of (butadiene-cyclobutene and hexatriene- cyclohexadiene interconversions) Cycloadditions (2+2), (2+4) and examples of other higher systems.

Sigmatropic reactions: (1,3), (1,5), and (3,3) sigmatropic reactions, Cope and Claisen rearrangement reactions. (Several suitable examples are to be taken for each class of transformation). Chelotropic and ene reaction. Several examples in each class. [16 Hours]

UNIT-III

Molecular Rearrangements and reactions: Clancian-Dennsted rearrangement, Cornforth rearrangement, Dimroth rearrangement, Meisenheimer rearrangement, Meyar-Schuster and Rupe rearrangement, Overman rearrangement, Payme rearrangement, Wittig- [1,2] and [2,3] rearrangement, Wolf rearrangement and Stevens rearrangement.

Corey-Nicolau microlactonization and De Mayo cycloaddition (2+2) photochemical. [16 Hours]

UNIT-IV

Green chemistry:

Microwave synthesis: Introduction, reaction vessel, reaction medium, concept, specific effects, atom efficiency, percentage atom utilization, advantage and limitation. N-alkylation and alkylation of active methylene compounds. Condensation of active methylene compounds with

aldehydes. Synthesis of Ibuprofen by BHC and BOOTS approach. Diels- Alder reaction, Leuckorts reductive amination of lactones. Oxidation of alcohols and sulphides. Supramolecules. **Modern Technology:** Modern techniques in organic synthesis. Brief outline of microwave. Ultra sound clay catalyzed techniques and uses of ionic liquids and polymer supports in organic synthesis. Phase-transfer catalyst & Crown-ethers. Super critical fluid extractions. [16 Hours]

Books Recommended:

1. Photochemistry, R. B. Cundal and A. Gilbert, Thomas Nelson and Sons Ltd. London, 1st edn. (1970).
2. Organic Photochemistry, J. M. Coxon and B. Halton, Cambridge Univ. Press, London 1st Edn. (1974).
3. Molecular reaction and Photochemistry, C. H. Depuy and O. S. Chapman, Prentice Hall, India, New Delhi, 1st Edn. (1972).
4. Orbital Symmetry, R. E. Lehr and A. P. Marchand, Academic Press, New York, 1st Edn. (1972).
5. Molecular Orbital theory for Organic Chemistry, A. Sreitweiser. Wiley and Sons, New York, 1st Edn. (1961).

SCP 4.2: ORGANIC CHEMISTRY PRACTICAL– IV

Isolation and Characterization of following Natural Products:

1. Caffeine from Tea leaves.
2. Lycopene from Tomato.
3. Caseine from Milk.
4. Herperidines from Orange Peel.

Estimation of functional groups -OH, -NH₂, -NO₂ and O-Methyl.

Books Recommended:

1. Natural products, A laboratory Guide – R. Ikan, Academic Press, London (1969).
2. Laboratory experiments in organic chemistry- Arun Sethi, New Age International Ltd. New Delhi (2006).
3. A Hand book of Organic chemistry – H. T. Clarke.
4. Vogel's text book of practical organic chemistry, revised 5th edn, Addison Wesley, Longman Ltd, UK (1997).

HCMP 4.3: MAJOR PROJECT

The project work may include inplant training in industries/short term work in the department/ other department or institution/ R & D organization/ review of current literature/ theoretical method computer applications/ experimental work may involve studies on synthesis of novel and known organic compounds, metal complexes and their characterization by physical and chemical methods/ drug analysis/ Biological activity of reported or unreported research work/ water, air and soil analysis/ pollution studies/ estimation of food adulterants.

In case of students working outside the campus the supervisor/ staff member incharge visit the place of work during the period and may be eligible for TA and DA as per university rules.

Books Recommended:

1. Applications of computers in chemistry- Raman.
2. Computers and their applications to chemistry- Ramesh Kumar, Narosa Publishing House (2002).
3. Laboratory experiments in organic chemistry – Arun Sethi, New Age International ltd. New Delhi (2006).
4. A Hand book of Organic chemistry – H. T. Clarke.
5. Vogel's text book of practical organic chemistry, revised 5th edn. Addison Wesley, Longman Ltd, UK (1997).