INTERNATIONAL COLLEGE FOR GIRLS (AUTONOMOUS)
Semester I

Deptt. of Chemistry

Paper I : Molecular Structure and Bonding

Paper Code : CHY 101 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn molecular structure, types of bonding in main group elements and basics of conductors, semiconductors and superconductors.

Pre requisite : Introductory study of different types of bonding and their general properties mentioned in semester I.

I The Ionic Bond **7 hrs**

Structures of ionic solids; radius ratio rules- calculation of limiting radius ratio values for coordination number 3,4 and 6; close packing; classification of ionic structures, ionic compounds of the type AX (ZnS, NaCl, CsCl) and AX_2 (CaF_2-Fluorite), cautionary word on radius ratio rule; calculation of lattice energy, factors affecting lattice energy, the Born Haber cycle and its application; solvation energy and solubilities of ionic substances; stoichiometric and non stoichiometric defects.

II The Covalent Bond **7 hrs**

The Lewis theory, octet rule, exceptions to octet rule; valence bond theory (Heitler and London approach) and its limitations; resonance; directional character of covalent bond, various types of hybridization and shapes of molecules; VSEPR theory, effect of lone pairs and electronegativity, isoelectronic principle, examples using VSEPR theory- NH_3, H_3O^+, SF_4, ClF_3, ICl_2, H_2O; polarizability of ions, Fajan's rule and consequences of polarization, dipole moment and percentage ionic character in covalent compounds.

III Molecular Orbital Approach in Covalent Bond **6 hrs**

Introduction, LCAO approach, combination of orbitals (s-s, s-p, p-p, non-bonding combination of orbitals), examples of molecular orbital treatment for homonuclear diatomic molecules – H_2^+, H_2, He_2, B_2, C_2, N_2, Be_2, O_2, O_2^{+1}, O_2^{-1}, O_2^{-2}, F_2, examples of molecular orbital treatment for heteronuclear diatomic molecules- NO, NO^+, CO molecule, comparison of VBT and MOT; bond energy and bond length.

IV The Metallic Bond **5 hrs**

Multicentred bonding in electron deficient molecule; general properties of metals– conductivity, lustre, malleability, ductility, crystal structures; theories of bonding in metals – free electron theory, valence bond theory and band theory – conductors, insulators and semi-conductors; superconductors.

V Weak Interactions 5 hrs

Van der Waal's forces: ion-dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole – induced dipole interactions, repulsive forces.

Hydrogen bond: types, theories and properties of H-bond, effects of H-bond on physical properties.

Books Recommended:

Text/References:

1. A New Concise Inorganic Chemistry; Fifth Edition; J.D. Lee; Blackwell Science, London, 1989.
2. Inorganic Chemistry; Third Edition; D.F. Shriver and P.W. Atkins; Oxford University Press, New York, 1999.
3. Inorganic Chemistry; Third Edition; Gary L. Miessler and Donald A. Tarr; Pearson Education Inc. Singapore, 2005.
4. Concepts and Models of Inorganic Chemistry; Third Edition; Bodie Douglas, Darl McDaniel, John Alexander; John Wiley and Sons, Singapore, 1994.
5. General and Inorganic Chemistry (Part - II); R. Sarkar; New Central Book Agency (P) Ltd. Kolkata; 2005.
6. Inorganic Chemistry; Third Edition; Alan G. Sharpe; AWL Publication, Delhi, 1999.

Paper II - Some Concepts of Organic Chemistry and Hydrocarbons

Paper Code : CHY 102 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objective:
To learn about molecular shape and structure to determine reactivity.

I Basics of Organic Reactions and Alkanes 7 hrs

Pre requisite: Inductive effect, electromeric effect, introduction to hydrocarbons, branched and unbranched alkanes, physical properties, different methods of formation of alkane, conformation of alkanes and cycloalkanes.

Chemical Reactions: charge attraction, orbital overlapping, energy profile diagram, hyperconjugation, applications of different electronic effects (inductive effect, electromeric effect, and mesomeric effect).
Alkanes: Method of formation from Corey-House reaction; combustion and elemental analysis, pyrolysis (cracking); CFC's and green house effect; reactivity of alkanes- bond dissociation energies, halogenation with special reference to generation of free radicals, reactivity and selectivity; orbital structure of cyclopropane .

II Alkenes: Structure and Reactivity 5 hrs

Pre requisite: Hybridization of carbon, cis-trans isomerism, IUPAC nomenclature, physical properties.
Structure and bonding in alkenes, unsaturation number; relative stability of alkene isomers by Saytzeff's rule and Hoffmann's rule; heat of formation and heat of hydrogenation; methods of formation – dehydration of alcohols (formation of carbocation, structure and stability), dehydrohalogenation of alkyl halide, regioselectivity;

III Addition Reactions of Alkenes (concept of cyclic halonium ion; trans mechanism)7hrs
Addition of hydrogen halide to alkenes according to Markovnikov's rule and Kharasch-Mayo effect, reaction with halogens – addition of Br_2, Cl_2 and halohydrins; conversion of alkenes into alcohols (oxymercuration-reduction, hydroboration-oxidation, comparison of both the above methods, hydroxylation of alkenes with $KMnO_4$ and OsO_4); ozonolysis of alkenes, determination of structure of alkenes.

IV Dienes 5 hrs
Structure and stability of conjugative and cumulative dienes, resonance and molecular orbital structure of allene and 1,3-butadiene; Diels' Alder reaction; addition of hydrogen halides to conjugated dienes – 1,4 v/s 1,2 addition (formation, structure and stability of allylic carbocation).

V Alkynes **6 hrs**

Pre requisite: Nomenclature, structure and bonding, physical properties, hydroboration-oxidation reaction.

Structure and stability; acidity of terminal alkynes, acetylide anions; reactions – electrophilic addition, comparative reactivities of alkenes and alkynes including the concept of polarisability, conversion of alkynes to aldehydes and ketones via hydration of alkynes, reduction of alkynes – catalytic hydrogenation, dissolving metal reduction; industrial applications of alkynes.

Books Recommended:

Text/References:

1. Organic Chemistry; Fourth Edition; G. Marc Loudon; Oxford University Press, New York, 2002.
2. Organic Chemistry; Seventh Edition; T.W. Graham Solomons & Craig B. Fryhle; John Wiley and Sons, Inc. USA, 1998.
3. Organic Chemistry; Sixth Edition; Robert Thornton Morrison & Robert Neilson Boyd; Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
4. Organic Chemistry; First Edition; Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers; Oxford University Press, USA, 2001.

Paper III - States of Matter

Paper Code : CHY 103 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn about mathematical concepts which will be helpful in chemical derivations and to enhance the knowledge on principles and bulk property of matter.

I Mathematical Concepts **6 hrs**

Pre requisite: Logarithmic relations

Derivatives and its meaning, Differentiation of functions like, x^n e^x, log x and trigonometric functions; rules of differentiation; maxima and minima; asymptotes, curve sketching, linear graphs and calculation of slopes; partial differentiation and reciprocity relations; Integration of some useful/relevant functions; Permutations and Combinations; Probability.

II Gaseous State **7 hrs**

Pre requisite: Gas laws.

Postulates of kinetic theory of gases, deviation from ideal behaviour, van der Waals equation of state.
Molecular velocities: root mean square, average and most probable velocities; qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, collision frequency, mean free path and collision diameter; Liquefaction of gases (based on Joule-Thomson effect).
Critical Phenomena: PV isotherms of real gases, continuity of states, the isotherms of van der Waals equation, relationship between critical constants and van der waals constants, the law of corresponding states, reduced equation of state.

III Liquid State **6 hrs**
Qualitative treatment of the structure of the liquid state, intermolecular forces; physical properties, vapour pressure, heat of vaporization, Trouton's rule; surface tension and its measurement, effect of temperature; viscosity and its measurement, effects of temperature, coefficient of viscosity; application of surface tension and viscosity in determination of chemical constitution.
Liquid Crystals: classification, structure of nematic, smectic and cholestric phases, application of liquid crystals.

IV Solid State **6 hrs**
An introduction to space lattice and unit cell; laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry, symmetry elements in crystals; X-ray diffraction by crystals, derivation of Bragg's equation, determination of crystal structure of NaCl, KCl and CsCl by powder method.

V Colloidal State **5 hrs**

Pre requisite: Definition and classification.

Solids in liquids (Sols): properties- kinetics, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.
Liquid in liquids (Emulsions): types, preparation, emulsifier.
Liquids in solids (Gels): classification, preparation and properties, inhibition; general application of colloids.

Books Recommended:

Text/References:

1. A Text Book of Physical Chemistry; A.S. Negi, S.C. Anand; New Age International (P) Limited, New Delhi, 2002.
2. The Elements of Physical Chemistry; P.W. Atkins; Oxford University Press, 1996.
3. Physical Chemistry; Seventh Edition; R.A. Alberty; Wiley Eastern Ltd., Singapore, 1987
4. University General Chemistry; C.N.R. Rao; Macmillan India Ltd., New Delhi, 1998.
5. Physical Chemistry Through Problems; S.K. Dogra and S.Dogra; Wiley Eastern Ltd, New Delhi, 2001.

Paper IV : Laboratory Course-I

Paper Code : CHY 104 **Max. Marks: 100**
Contact Hr./Week : 4 **(CA :30, SEE: 70)**
Credits : 2

Inorganic Chemistry **42 hrs**

Qualitative Analysis: Semimicro Analysis – (three cations and three anions)
a) cation analysis, separation and identification of ions from groups I-VI.
b) anion analysis. (no interfering radicals and insolubles).

Organic Chemistry **8 hrs**
a) Detection of elements (Nitrogen, Sulphur and Halogens) in simple organic compounds.
b) Determination of the melting / boiling points of organic compounds.

Physical Chemistry **10 hrs**

Surface Tension: To determine the percentage composition of a mixture (non interacting systems) by surface tension method.

Viscosity: To determine the viscosity of amyl alcohol in water at different concentration and calculate the excess viscosity of these solutions.

Colloids: To prepare ferric hydroxide sol and compare the precipitating power of mono, bi and trivalent anions.

Books Recommended:

1. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut, 2005.
2. Vogel's Qualitative Inorganic Analysis; Sixth Edition; G. Svehla; Orient Longman Ltd. New Delhi.
3. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
4. Vogel's Textbook of Practical Organic Chemistry; Fifth Edition; B.S. Furniss, A.J. Hannaford, P.W.D. Smith, A.R. Tatchell; Addison-Wesley Longman Ltd., England, 1998.

Semester II
Paper I : Systematic Chemistry of Main Group Elements

Paper Code : CHY 201 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn gradation in properties of main group elements and theoretical concepts of volumetric analysis.

I s-Block Elements **6 hrs**

General properties and comparative study of alkali and alkaline earth metals, diagonal relationship, anamolous behaviour of Li and Be, salient features of hydrides and their classification (ionic, covalent and interstitial), solvation and complexation tendencies.

II Periodicity in Properties of p-Block Elements **7 hrs**

Pre requisite: General Properties of main group elements mentioned in semester II

Periodicity in properties of p-block elements with special reference to atomic and ionic radii, ionization energies, electron-affinity, electronegativity, allotropy, inert pair effect, catenation including diagonal relationship.

Some important compounds of p-block elements: group 13 elements – boron hydrides (diborane) and borazine; group 14 elements – silicates (classification and structural aspect); group 15 elements – structural aspects of oxides and oxy acids of N & P; group 16 elements – structural aspects of oxy acids of S including peroxo acids.

III Halogens and Noble Gases **6 hrs**

Unique position of Fluorine, basic nature of iodine, interhalogen compounds and polyhalides (only structural study).

Nobel gases- introduction, isolation, physical properties and uses, xenon compounds.

IV Oxidation and Reduction **6 hrs**

Reduction potentials – redox half reactions, concept of over potential; diagrammatic presentation of potential data (Latimer, Frost and Pourbaix diagrams); redox stability in water, reactions with water, disproportionation, oxidation by atmospheric oxygen; elements extracted by reduction – Ellingham diagrams.

V Basic Principles of Volumetric Analysis **5 hrs**

Pre requisite: Basic principles of acid base titrations.

Simple theoretical background of iodometric and iodimetric titrations, redox titrations, complexometric titrations and precipitation titrations.

Books Recommended:
Text/References:

1. A New Concise Inorganic Chemistry; Fifth Edition, J.D. Lee; Blackwell Science, London, 2000.
2. Inorganic Chemistry; Third Edition; D.F. Shriver and P.W. Atkins; Oxford University Press, New York, 1999.
3. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; ELBS, England, 1991.
4. Basic Concepts of Analytical Chemistry; S.M. Khopkar; New Age International Publishers.
5. Inorganic Chemistry; Third Edition; Alan G. Sharpe; AWL Publication, Delhi, 1999.
6. Foundations of Inorganic Chemistry; Mark J. Winter and John E. Andffrew; Oxford Science Publications, New York, 2000.

Paper II : Aromaticity and Stereochemistry

Paper Code : CHY 202 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn about the extra stability of some molecules through aromaticity and Huckel's rule and also about restricted and free rotation, molecular symmetry, enantiomeric and diastereomeric conditions.

I Aromaticity **5 hrs**

Pre requisite: Nomenclature of benzene derivatives (mono and disubstituted), physical properties

Introduction to aromatic compounds: Benzene, structure and stability, M.O concept, resonance and resonance energy; aromaticity and Huckel's (4n+2) rule, magnetic criteria.

II Directing Effects of Substituents **6 hrs**

Activating and deactivating effects of substituents, o/p directing group, m directing group, o/p ratio, ortho effect, aromatic electrophilic substitution – general pattern of the mechanism, σ and π complexes, energy profile diagram, halogenation, nitration, sulphonation and desulphonation, Friedel Crafts alkylation and acylation; side chain halogenation of alkyl benzenes (toluene, ethyl benzene).

Self Study: Hydrogenation of benzene derivatives, industrial use of aromatic hydrocarbons.

III Principles of Stereochemistry **7 hrs**

Geometrical isomerism: concept of restricted rotation – cis-trans, syn-anti and E,Z system of nomenclature, geometrical isomerism in oximes, amides and alicyclic compounds. Optical isomerism: elements of symmetry, concept of asymmetry and chirality, enantiomers and diastereomers, racemic mixture and meso isomers; molecular chirality – allenes and cyclophanes, relative and absolute configuration, nomenclature of optical isomers – D,L nomenclature, sequence rule and the R,S system of nomenclature, resolution of enantiomers; elementary concepts of asymmetric synthesis (concept of diastereomeric induction).

Self Study: Physical properties of enantiomers and diastereomers, optical activity, polarized light, optical activity of enantiomers.

IV Conformational Isomerism: Concept of Free Rotation **6 hrs**

Newman, Fischer, Sawhorse and Flying-wedge formula; conformation of n-butane, relative stability of conformational isomers, Baeyer's strain theory, theory of strainless rings, conformational analysis of cyclohexane – axial and equitorial bonds, the chair, boat and twist-boat forms of cyclohexane conformation, concepts of conformational locking; chair conformation of α and β glucose and their stability; monosubstituted cyclohexane – conformational analysis and stability, disubstituted cyclohexane – cis-trans isomerism and conformational analysis (dimethyl cyclohexane).

V Stereochemistry of Chemical Reactions 6 hrs

Stereochemistry of addition reactions – syn and anti addition, stereochemistry of Br_2 addition (stereospecific reactions); stereochemistry of other addition reactions – catalytic hydrogenation, hydroboration-oxidation, oxymercuration-reduction; stereochemistry of substitution reaction – retention, inversion and racemisation.

Books Recommended:

Text/References:

1. Organic Chemistry; Fourth Edition; G. Marc Loudon; Oxford University Press, New York , 2002.
2. Stereochemistry Confirmation and mechanism; Fourth Edition; P.S. Kalsi; New Age International (P) Ltd. Publishers, New Delhi, 1997.
3. Organic Chemistry; Seventh Edition; T.W. Graham Solomons & Craig B. Fryhle; John Wiley and Sons, Inc. USA, 1998.
4. Organic Chemistry; Sixth Edition; Robert Thornton Morrison & Robert Neilson Boyd; Prentice-Hall of India Pvt. Ltd , New Delhi, 2004.
5. Organic Chemistry; First Edition; Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers; Oxford University Press, USA, 2001.

Paper III : Solutions and Reaction Kinetics

Paper Code : CHY 203 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn about the fundamental laws of solutions, surface phenomena and know how reaction rate changes in terms of concentration and temperature.

I Solutions and Non-Ideal Solutions 7 hrs

Solutions: ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient.
Solution of gases in liquid: Henry's law and its experimental verification, deviation from Henry's law, effect of temperature.
Non ideal system: azeotropes – HCl-H_2O and ethanol-water systems.
Partially miscible liquids: phenol-water, trimethylamine-water, nicotine-water systems; lower and upper consolute temperature, effect of impurity on consolute temperature; immiscible liquids; steam distillation.

Self Study: Applications and limitations of Henry's law.

II Dilute Solutions– Colligative Properties 7 hrs

Introduction, colligative properties, Raoult's law, relative lowering of vapour pressure; osmosis, law of osmotic pressure and its measurement; elevation of boiling point and depression of freezing point; thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point; use of colligative properties in molecular weight determination; experimental methods for determining various colligative properties; non-ideal behaviour and Van't Hoff's factor 'i'.

Self Study: Reverse osmosis.

III Chemical Kinetics 6 hrs

Chemical kinetics and its scope, rate of a reaction, factors influencing rate of a reaction; mathematical characteristics of simple chemical reactions- zero order, first order, second order, pseudo order, half life and mean life; determination of the order of reaction– differential, integration, half life period and isolation method; radioactive decay as a first order phenomenon;

Self Study: Order, molecularity, rate law and rate constant.

IV Experimental Methods and Theories of Chemical Kinetics 5 hrs

Experimental methods of chemical kinetics – conductometric, polarimetry and spectrophotometer.
Theories of chemical kinetics – collision theory and transition state theory (elementary idea); Arrhenius equation and activation energy.

V Surface Chemistry 5 hrs

Sorption at surfaces, physical and chemical adsorption; Freundlich, Langmuir and Gibbs adsorption isotherms; catalytic activity at surfaces, catalyzed reaction – acid catalyzed, base catalyzed and acid-base catalyzed reactions.

Books Recommended:

Text/References:

1. A Text Book of Physical Chemistry; A.S. Negi, S.C. Anand; New Age International (P) Limited, New Delhi, 2002.
2. The Elements of Physical Chemistry; P.W. Atkins; Oxford University Press, 1996.
3. Physical Chemistry; Seventh Edition; R.A. Alberty; Wiley Eastern Ltd., Singapore, 1987
4. University General Chemistry; C.N.R. Rao; Macmillan India Ltd., New Delhi, 1998.
5. Physical Chemistry Through Problems; S.K. Dogra and S.Dogra; Wiley Eastern Ltd, New Delhi, 2001.

Paper IV: Laboratory Course-II

Paper Code : CHY 204 **Max. Marks: 100**
Contact Hr./Week : 4 **(CA :30, SEE: 70)**
Credits : 2

Inorganic Chemistry **6 hrs**

Calibaration of fractional weights, pipettes and burettes, preparation of standard solutions, dilution 0.1 M to 0.001 M solutions, buffer solutions.

Quantitative Analysis: Volumetric Analysis **(Any four)** **14 hrs**

a) Estimation of copper using sodium thiosulphate iodometrically.
b) Estimation of Fe^{+2} ion in ferrous ammonium sulphate with $K_2Cr_2O_7$ using internal indicator.
c) Determination of acetic acid in commercial vinegar using NaOH.
d) Determination of strength of acid from the mixture of strong acid and weak acid (eg. $H_2SO_4$and H_3PO_4).
e) Determination of strength of sodium carbonate in the mixture of washing soda and NaOH with HCl using phenolphthalein and methyl red indicators.

Organic Chemistry **28 hrs**

Stereochemical study of organic compounds via models: R,S configuration of optical isomers, E, Z configuration of geometrical isomers, conformational analysis of cyclohexane and mono substituted cyclohexane.

Qualitative Analysis

Detection of elements (Nitrogen, Sulphur and Halogens) and functional groups (phenols, alcohols, carboxylic acid, carbonyl, ester, carbohydrate, amine, amide and nitro) in simple organic compounds and determination of their melting/boiling points.

Physical Chemistry **12 hrs**

Chemical Kinetics

1. First Order Kinetics- Hydrolysis of methyl acetate catalyzed by HCl.
2. Second Order Kinetics- Saponification of ethyl acetate.

Books Recommended:

1. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
2. Vogel's Textbook of Practical Organic Chemistry; Fifth Edition; B.S. Furniss, A.J. Hannaford, P.W.D. Smith, A.R. Tatchell; Addison-Wesley Longman Ltd., England, 1998.
3. Organic Chemistry; Sixth Edition; Robert Thornton Morrison & Robert Neilson Boyd; Prentice-Hall of India Pvt. Ltd , New Delhi, 2004.
4. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut,2005.

Semester III

Paper I: Coordination Chemistry

Paper Code : CHY 301 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn the chemistry of d and f- block elements and basic concepts of coordination chemistry.

I Chemistry of Elements of First Transition Series 6 hrs

Pre requisite: An elaborate idea of periodic table and electronic configurations

Introduction, electronic configuration, characteristic properties of d-block elements– metallic character, variable oxidation states and their stability, density, melting point and boiling point., catalytic properties, ionization energies, magnetic properties and its origin, measurement of magnetic moments, colour, complexation tendencies.

II Chemistry of Elements of Second and Third Transition Series 5 hrs

Electronic configuration, general characteristics, comparison of the elements of first transition series with second and third transition series with special reference to magnetic property, spectral property, stability of variable oxidation states and stereochemistry, ionic radii, complexation tendencies; metal-metal bonding and cluster compounds (elementary approach)

III Basic Concepts of Coordination Chemistry 6 hrs

Introduction, Werner's coordination theory, concept of effective atomic number (EAN concept), classification of ligands, chelation, polynuclear complexes, nomenclature of coordination compounds

IV Models and Stereochemistry 6 hrs

Isomerism in coordination compounds, structural isomerism and its types, stereochemistry of complexes of 4 and 6 coordination number, valence bond theory applied on octahedral, tetrahedral and square planar complexes.

V Chemistry of Inner-Transition Elements 7 hrs

Lanthanides: definition, position of lanthanides in the periodic table, separation of rare earth elements (solvent extraction and ion exchange method only), electronic configuration, physical properties, oxidation states, atomic and ionic radii, lanthanide contraction, causes and consequences of lanthanide contraction, magnetic and spectral properties; comparison between d- and f- block elements.

Actinides: definition, position of actinides in the periodic table, electronic configuration, general characteristics of actinides and their comparison with lanthanides with special reference to magnetic properties, spectral properties and oxidation states.

Books Recommended:

Text/References:

1. A New Concise Inorganic Chemistry; Fifth Edition; J.D. Lee; Blackwell Science, London, 2000.
2. Inorganic Chemistry; Third Edition; D.F. Shriver and P.W. Atkins; Oxford University Press, New York, 1999.
3. Concepts and Models of Inorganic Chemistry; Bodie Douglas, Darl McDaniel, John Alexander; John Wiley and Sons, Singapore, 2001.
4. Essential Trends in Inorganic Chemistry; D.M.P. Mingos; Oxford University Press, New York, 1998.
5. Nomenclature of Inorganic Chemistry – Recommendations – 1990; Edited by G.J. Leigh; Jain Interscience Press, Delhi, 1994.

Paper II: Functionalized Organic Compounds
(Carbon-Halogen and Carbon- Oxygen/Sulphur Bonds)

Paper Code : CHY 302 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objective:
To learn about reaction and reactivity of some specific functional groups.

I Introduction to Alkyl Halides, Alcohols, Ethers, Thiols and Sulphides 6 hrs

Pre requisite: Nomenclature.

Structures, effect of bond polarity and H-bond on physical properties, solubility; acid-base nature of alcohols, thiols and phenols, formation of alkoxides, mercaptides and phenoxides, polar effects on acidity, role of the solvent in alcohol acidity; curing a disease with mercaptide; cation binding molecules **–** host-guest chemistry.

II Chemistry of Alkyl Halide 7 hrs

Pre requisite: S_N2 and S_N1 reactions, Saytzeff's and Hoffmann rules

Substitution reactions: introduction, stereochemistry and factors affecting reactivity in substitution reactions.
Elimination reactions: introduction, β elimination reactions – E_2 and E_1 reactions, orientation in β elimination reactions.
Substitution v/s elimination.

Self Study: Important reactions of alkyl halides.

III Reactivity of Vinylic, Arylic, Allylic and Benzylic Substrates 6 hrs
Lack of reactivity of vinyl and aryl halide under S_N1 and S_N2 condition, elimination reaction of vinyl halide.
Nucleophilic substitution reaction of aryl halides: addition-elimination mechanism, elimination-addition (benzyne) mechanism; reactions involving allylic and benzylic carbocations, allylic and benzylic S_N2 reactions.

IV Chemistry of Alcohols and Thiols 6 hrs

Pre requisite: Monohydric alcohols, methods of formation by reduction of aldehydes, ketones, carboxylic acid and esters, biological oxidation of ethanol.

Reactions of alcohols: reaction with thionyl chloride (S_Ni reaction) and phosphorous tribromide; oxidation to aldehydes, ketones and carboxylic acid; comparative study of the oxidation of alcohols and thiols.
Dihydric alcohols: chemical reactions of vicinal glycols, oxidative cleavage with $[Pb(OAc)_4]$ and HIO_4; Pinacol- pinacolone rearrangement.

V **Chemistry of Phenols** **5 hrs**

Reactivity of the aryl-oxygen bond; reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation, Fries rearrangement, Claisen rearrangement, Gattermann synthesis, Houben–Hoesch reaction, Lederer–Manasse reaction, Reimer-Tiemann reaction.

Self Study: Preparation of phenols

Books Recommended:

Text/References:

1. Organic Chemistry; Fourth Edition; G. Marc Loudon; Oxford University Press, New York, 2002.
2. Organic Chemistry; Seventh Edition; T.W. Graham Solomons & Craig B. Fryhle; John Wiley and Sons, Inc. USA, 1998.
3. Organic Chemistry; Sixth Edition; Robert Thornton Morrison & Robert Neilson Boyd; Prentice-Hall of India Pvt. Ltd , New Delhi, 2004.
4. Organic Chemistry; First Edition; Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers; Oxford University Press, USA, 2001.

Paper III : Thermodynamics and Electrochemistry

Paper Code : CHY 303 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn the basic principles involved in energetics of chemical reactions and role of enthalpy in chemical reactions and the behaviour of electrolytes in solution with the concepts of conductivity measurements.

I Thermodynamics: The First Law 6 hrs

An overview of thermodynamic terms, intensive and extensive properties, state and path functions and their differentials; thermodynamic processes; concept of heat and work.
First law of thermodynamics: statement, definition of internal energy and enthalpy, heat capacity, heat capacities at constant volume and pressure and their relationship; Joul's law-Joule-Thomson coefficient and inversion temperature; calculations of w, q, dU and dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

II Thermodynamics: Applications of First Law - Thermochemistry 6 hrs

Standard state, standard enthalpy of formation; Hess's law of heat summation and its applications; heat of reactions at constant pressure and at constant volume; enthalpy of neutralization; bond dissociation energy and its calculation from thermo-chemical data; temperature dependence of enthalpy; Kirchoff's equation.

III Thermodynamics: The Second Law and Third Law 7 hrs

Second law of thermodynamics: need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, thermodynamic scale of temperature.
Concept of entropy: entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical processes, Clausius inequality, entropy as a criteria of spontaneity and equilibrium, entropy change in ideal gases and mixing of gases.
Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data.

IV Electrochemistry: Electrolytic Conduction 6 hrs

Electrical transport, conductance in metals and electrolytes, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution.
Applications of conductivity measurements: determination of degree of dissociation, acid dissociation constant Ka, solubility product of a sparingly soluble salt; conductometric titrations.

V Electrochemistry: Ionic Equilibria 5 hrs

Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes; Ostwald's dilution law, its uses and limitations; Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only); migration of ions and Kohlraush law; transport number – definition and determination by Hittorf and moving boundary method.

Books Recommended:

Text/References:

1. A Text Book of Physical Chemistry; A.S. Negi, S.C. Anand; New Age International (P) Limited, New Delhi, 2002.
2. The Elements of Physical Chemistry; P.W. Atkins; Oxford University Press, 1996.
3. Physical Chemistry; Seventh Edition; R.A. Alberty; Wiley Eastern Ltd., Singapore, 1987
4. University General Chemistry; C.N.R. Rao; Macmillan India Ltd., New Delhi, 1998.
5. Physical Chemistry Through Problems; S.K. Dogra and S.Dogra; Wiley Eastern Ltd, New Delhi, 2001.
6. Physical Chemistry; G.M. Barrow; International Students Edition; McGraw Hill, New Delhi, 1994.

Paper IV:Laboratory Course-III

Paper Code : CHY 304 **Max. Marks: 100**
Contact Hr./Week : 4 **(CA :30, SEE: 70)**
Credits : 2

Inorganic Chemistry

Synthesis **6 hrs**

a) Preparation of Tetraaminecopper (II) sulphate
b) Preparation of Bis-Dimethylglyoxime-nickel (II)
c) Preparation of Sodiumtrioxalatoferrate (III)
d) Preparation of cis and trans-bisoxalatodiaquachromate (III).

Organic Chemistry **34 hrs**

Qualitative Analysis

Identification of an organic compound through the functional group analysis, determination of melting point/boiling point and preparation of suitable derivatives.

Physical Chemistry **20 hrs**

Thermochemistry

1. To determine the enthalpy of neutralisation of strong acid and strong base.
2. To determine the enthalpy of neutralization a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of weak acid/weak base.

Conductometry

To determine the strength of acid (HCl/CH_3COOH) conductometrically using standard alkali solution.

Books Recommended:

1. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
2. Vogel's Textbook of Practical Organic Chemistry; Fifth Edition; B.S. Furniss, A.J. Hannaford, P.W.D. Smith, A.R. Tatchell; Addison-Wesley Longman Ltd., England, 1998.
3. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut,2005.

Semester IV

Paper I: Selected Topics in Chemistry

Paper Code : CHY 401 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn nuclear chemistry, applications of radioactivity and the basic principles of analytical techniques.

I **Acids and Bases** **5 hrs**
Arrhenius concept, Bronsted-Lowry theory, general theory of solvent system, Lewis acid-base concept, HSAB principle and its applications.

II **Non-aqueous Solvents** **6 hrs**
Classification of solvents, physical properties of ionising solvents, water as universal solvent, liquid ammonia and liquid sulphur dioxide as solvent.

III **Nuclear Chemistry** **7 hrs**
Nuclear particles, Soddy-Fajan's displacement law (group displacement law); nuclear forces– forces operating between nucleons (n-n, p-p, n-p), quantitative idea of stability of nucleus, packing fraction, binding energy; nuclear reactions (fission and fusion reactions only); modes of decay; natural and artificial radio activity, transmutation, applications of radioactivity.

Self Study: Basics of fission and fusion reactions, half life period, radioactivity.

IV **Basic Principles of Analytical Techniques** **6 hrs**
Data Analysis: errors in chemical analysis, classification of errors, accuracy and precision, minimisation of errors; significant figures; statistical analysis – mean and standard deviation; sampling in analysis, rejection of results, presentation of data.
Gravimetric analysis: theory of precipitation, co-precipitation, post-precipitation from homogeneous solution and purification of precipitates.

V **Chromatographic Technique** **6 hrs**
Classification, basic principles of thin layer chromatography, paper chromatography and column chromatography; nature of adsorbent, solvent system, R_f values.

Books Recommended:

Text/References:

1. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
2. Nuclear Chemistry Through Problems; Fourth Edition Arnikar & Rajurkar; New Age Publications, New Delhi, 1997.
3. Quantitative Analysis; Sixth Edition; R.A. Day, Jr. and A. L. Underwood; Prentice Hall of India Private Limited, New Jersey U.S.A., 1998.
4. Basic Concepts of Analytical Chemistry; S.M. Khopkar; New Age International Publishers.
5. A New Concise Inorganic Chemistry; Fifth Edition J.D. Lee; Blackwell Science, London, 2000.

Paper II: Functionalized Organic Compounds
(Carbonyl Compounds, Carboxylic Acids and its Derivatives)

Paper Code : CHY 402 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn how different compounds are prepared by the reactions of carbonyl moiety and to introduce how the reactivity can be explained to allow the introduction of functional group next to carbonyl group.

I Chemistry of Aldehydes and Ketones 6 hrs

Pre requisite: Nomenclature, synthesis – oxidation of alcohols, Friedel Crafts acylation, hydration of alkynes, hydroboration-oxidation of alkynes, ozonolysis of alkenes, periodic cleavage of glycols, reduction to alcohols, oxidation to carboxylic acid

Synthesis from 1,3-dithianes and enamines; structure of carbonyl group; reactions of carbonyl group – nucleophilic addition reaction (mechanism), reactions with organometallic reagents, primary and secondary amines, reduction to methylene group-Wolff-Kishner reduction, Clemmensen reduction; the Wittig alkene synthesis.

II Chemistry of Enolate ions, Enols and α,β-Unsaturated Carbonyl Compounds 6 hrs
Introduction, acidity of carbonyl compounds – formation of enolate ions, reactions of enolate ions (brief idea), enolization of carbonyl compounds; α – halogenation of carbonyl compounds, acid catalyzed α-halogenation, base catalyzed halogenation – the haloform reaction; alkylation of ester- enolate ions, malonic ester synthesis, direct alkylation of enolate ions derived from mono esters; acetoacetic ester synthesis; an overview of α, β unsaturated carbonyls and Michael addition.

III Some Important Name Reactions of Carbonyl Compounds 6 hrs
Aldol addition and Aldol condensation – base catalyzed, acid catalyzed, special types of aldol condensation (crossed and intramolecular); condensation reaction involving ester-enolate ions – Claisen condensation, crossed Claisen condensation, Dieckmann condensation; Benzoin condensation, Perkin reaction, Knoevenagel reaction, Cannizzaro reaction, Mannich reaction, Baeyer-Villiger oxidation.

IV Chemistry of Carboxylic Acid 7 hrs

Pre requisite: Nomenclature, structure and physical properties, reduction of carboxylic acid to primary alcohol.

Acidity of carboxylic acids, effect of substituents on acidity; reactions of carboxylic group– acid and base catalyzed esterification, esterification with diazoalkane, conversion of carboxylic acid into acid chlorides and anhydrides, decarboxylation, Hell Volhard Zelinsky reaction.

V Carboxylic Acid Derivatives: Esters, Acid chlorides, Amides and Anhydrides 5 hrs

Pre requisite: Nomenclature, preparation of carboxylic acid derivatives.

Basicity, hydrolysis, mechanism and reactivity in nucleophilic acyl substitution; reactions with nucleophiles – reaction with ammonia and amines, trans-esterification; soaps and detergents – an introductory concept of surfactants and micelles formation.

Books Recommended:

Text/References:

1. Organic Chemistry; Fourth Edition; G. Marc Loudon; Oxford University Press, New York, 2002.
2. Organic Chemistry; Seventh Edition; T.W. Graham Solomons & Craig B. Fryhle; John Wiley and Sons, Inc. USA, 1998.
3. Organic Chemistry; Sixth Edition; Robert Thornton Morrison & Robert Neilson Boyd; Prentice-Hall of India Pvt. Ltd , New Delhi, 2004.
4. Organic Chemistry; First Edition; Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers; Oxford University Press, USA, 2001.

Paper III: Applications of Thermodynamics

Paper Code : CHY 403 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn the laws of thermodynamics in understanding homogenous and heterogenous equilibria and the theories and concept of electrochemistry in redox system and cells.

I Thermodynamics: Free Energy Functions 5 hrs

Gibbs and Helmholtz functions, Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantages over entropy change, variation of G & A with P, V & T.

II Thermodynamics: Chemical Equilibrium 6 hrs

Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le Chatelier's principle,reaction isotherm and reaction isochore- Clapeyron equation and Clausius -Clapeyron equation, applications

III Heterogeneous Equilibria – The Phase Rule 7 hrs

Introduction to phase, component and degree of freedom, derivation of Gibbs phase rule; phase equilibria of one component system-water, CO_2 and sulphur system.

Phase equilibria of two component system-solid-liquid equilibria, simple eutectic – Bi-Cd, Pb-Ag systems, desilverisation of lead.

Solid solutions: compound formation with congruent melting point (Mg-Zn) and incongruent melting point (NaCl-H_2O), ($FeCl_3$ – H_2O) and ($CuSO_4$ – H_2O) system; freezing mixtures (acetone – dry ice).

Nernst distribution law – thermodynamic derivation, applications.

Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point.

IV Electrochemistry I: Equilibrium in Redox System 5 hrs

Types of reversible electrodes – gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrodes; electrode reactions, Nernst equation, derivation of cell E.M.F. and single electrode potential; standard hydrogen electrode- reference electrodes, standard electrode potential, sign conventions, electrochemical series and its significance.

Electrolytic and Galvanic cells: reversible and irreversible cells, conventional representation of electrochemical cells.

V Electrochemistry II: Electromotive Force 7 hrs

EMF of a cell and its measurements, computation of cell EMF, calculation of thermodynamic quantities of cell reactions (ΔG, ΔH & K).

Concentration cell with and without transport, liquid Junction potential, applications of concentration cell - valency of ions, solubility product, activity coefficient, potentiometric titrations.

Definition of pH and pKa, determination of pH using hydrogen, quinhydrone and glass electrodes and by potentiometric method.

Books Recommended:

Text/References:

1. A Text Book of Physical Chemistry; A.S. Negi, S.C. Anand; New Age International (P) Limited, New Delhi, 2002.
2. The Elements of Physical Chemistry; P.W. Atkins; Oxford University Press, 1996.
3. Physical Chemistry; Seventh Edition; R.A. Alberty; Wiley Eastern Ltd., Singapore, 1987
4. University General Chemistry; C.N.R. Rao; Macmillan India Ltd., New Delhi, 1998.
5. Physical Chemistry Through Problems; S.K. Dogra and S.Dogra; Wiley Eastern Ltd, New Delhi, 2001.

Paper IV: Laboratory Course-IV

Paper Code : CHY 404 **Max. Marks: 100**
Contact Hr./Week : 4 **(CA :30, SEE: 70)**
Credits : 2

Inorganic Chemistry **20 hrs**

Quantitative Analysis: Gravimetric Analysis

a) Estimation of Cu as CuSCN,
b) Estimation of Zn as Zinc ammonium phosphate,
c) Estimation of Pb as $PbCrO_4$

Organic Chemistry **26 hrs**

Qualitative Analysis: Chromatographic Techniques (Practice exercise)

Thin Layer Chromatography

a) Separation of 2,4 –dinitrophenylhydrazones of acetone, 2-butanone, hexan-2- one and hexane-3-one using toluene and light petroleum (40:60).
b) Separation of green leaf pigments (spinach leaves may be used).

Ascending paper chromatography
a) Separation of green leaf pigments (spinach leaves may be used).

Circular paper chromatography
a) Separation of amino acids or carbohydrates.

Quantitative Analysis

a) To determine the neutralization equivalent of the acid.
b) Estimation of glucose by Fehling's solution/Benedict's solution method.

Physical Chemistry **14 hrs**

Phase Equilibrium

a) To determine the mutual solubility curve of phenol – water system and their consolute point.
b) To study the effect of a solute (NaCl/succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the system.

pH-metry

Titration of acetic acid against NaOH , verification of Henderson's equation and determination of pKa value.

Distribution Law
To study the distribution of iodine in water and carbon tetrachloride.

Books Recommended:

Text/References:

1. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
2. Vogel's Textbook of Practical Organic Chemistry; Fifth Edition; B.S. Furniss, A.J. Hannaford, P.W.D. Smith, A.R. Tatchell; Addison-Wesley Longman Ltd., England, 1998.
3. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut,2005.

Semester V

Paper I: Transition Metal Complexes: Bonding and Spectra

Paper Code : CHY 501 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn the nature of metal-ligand bonding in coordination compounds and understand the magnetic and spectral aspects of transition metal complexes and their applications.

I Metal-ligand Bonding in Transition Metal Complexes –I **7 hrs**

Pre requisite: Valence bond theory.

Limitations of VBT, crystal field theory- important postulates, crystal field splitting of d-orbitals in octahedral and tetrahedral complexes, factors affecting the magnitude of Δ_0, calculation of crystal field stabilization energy; strong and weak ligands, spectrochemical series; distribution of d-electrons in t_{2g} and e_g orbitals in octahedral and tetrahedral complexes.

II Metal-ligand Bonding in Transition Metal Complexes –II **6 hrs**

Distortion of octahedral complexes, crystal field splitting of d-orbitals in square planar complexes and Jahn Teller theorem; use of CFSE values, number of unpaired electrons and high spin (HS) and low spin (LS) complexes,applications and limitations of CFT.

III Magnetic Properties of Transition Metal Complexes **5 hrs**

Pre requisite: Types of magnetism.

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin only formula, correlation of μ_s and μ_{eff} values; orbital contribution to magnetic moments, applications of magnetic moment data for 3d-complexes.

IV Electronic Spectra of Transition Metal Complexes **6 hrs**

Types of electronic transitions; coupling of orbital angular momenta and spin angular momenta (in p^2 and d^2 configuration), spin orbit coupling/LS coupling, determining the ground state terms – Hund's rule, hole formulation, calculation of the number of micro states; selection rules- Laporte 'orbital' selection rule, spin selection rule, spectroscopic ground states; Orgel energy level diagram for d^1-d^9 states, discussion of electronic spectrum of $[Ti(H_2O)_6]^{+3}$ complex.

V Thermodynamic and Kinetic Stability of Metal Complexes **6 hrs**

Definition of stability, stepwise and overall formation constants, kinetic v/s thermodynamic stability, labile and inert complexes, factors affecting the stability of complexes; the ligand substitution reactions in square-planar complexes, the trans-effect, theories of trans-effect and its uses.

Books Recommended:

Text/References:

1. Inorganic Chemistry; Third Edition; Alan G. Sharpe; AWL Publication, England, 1999.
2. Inorganic Chemistry; Third Edition; D.F. Shriver and P.W. Atkins; Oxford University Press, New York, 1999.
3. A New Concise Inorganic Chemistry; Fifth Edition; J.D. Lee; Blackwell Science, London, 2000.
4. Concepts and Models of Inorganic Chemistry; Third Edition; Bodie Douglas, Darl McDaniel, John Alexander; John Wiley and Sons, Singapore, 2001.
5. General and Inorganic Chemistry (Part - II); R. Sarkar; New Central Book Agency (P) Ltd. Kolkata, 2005.
6. Coordination Chemistry; D. Banerjea; Tata Mc Graw Hill Publishing Company Limited, New Delhi, 1993.

Paper II: Biomolecules, Polymers and Spectral Techniques

Paper Code : CHY 502 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn the role of spectroscopy to solve the structure of unknown compounds and making and manipulation of natural products.

I Proteins and Amino Acids **6 hrs**

Amino acids: classification, structure and stereochemistry, acid base behaviour, isoelectric point, electrophoresis, preparation and reactions of α-amino acids.
Proteins: peptide linkages, structure and classification of primary, secondary and tertiary proteins and denaturation.
Nucleic acids: introduction, protein synthesis, functions.

Self Study: Structure of nucleic acids, ribonucleosides and ribonucleotides, double helical structure of DNA.

II Carbohydrates **7 hrs**

Structural and natural occurrence, stereochemistry of sugars; structure of glucose, reactions of monosaccharides, oxidation reactions, ascending and descending of monosaccharides; an introduction to disaccharides – α and β glycosidic linkages; reducing and non-reducing sugars.

III Polymers **5 hrs**

Classification, condensation and addition polymerizations – mechanism of free radical, cationic, anionic addition polymerization; Ziegler-Natta catalyzed reactions, stereochemistry and kinetics; vinyl polymers (PVC, poly vinyl acetate, polystyrene), teflon, urea-formaldehyde resin and phenol-formaldehyde resins, polyurethanes; synthetic fibres– nylon-66, nylon-6, polyester, polyacrylic fibres; plasticizers; natural and synthetic rubber, vulcanization.

IV Basic Concepts of Spectroscopy **5 hrs**

Electromagnetic radiation, quantization of energy, regions of electromagnetic spectrum, units of measurement; transitions – electronic, molecular, nuclear; absorption of electromagnetic radiations by organic molecules, transmittance and absorbance; Fourier-Transform spectroscopy.
Self Study: Lambert – Beer law, molar absorptivity.

V Application of UV and IR in Structure Elucidation **7 hrs**

UV Spectroscopy: different electronic transitions and symmetry rules, effect of solvent on transitions, effect of conjugation, concept of chromophores and auxochromes, bathochromic, hypsochromic, hyperchromic and hypochromic shift; Woodward Fieser rules and its applications on enes, dienes, α,β-unsaturated carbonyls and extended conjugations.

IR absorption spectroscopy: molecular vibrations, Hooke's law, different regions of IR spectrum (finger print and functional group region), selection rules, characteristic intensity

and position of IR bands of various functional groups (alkanes, alkenes, alkyl halides, alcohols, ethers, carbonyl compounds, primary and secondary amines, carboxylic acids and its derivatives); effect of solvent and hydrogen bonding.

Books Recommended:

Text/References

1. Organic Chemistry Vol. I & II; Fifth Edition; I.L. Finar; Longman Scientific and Technical, Singapore, 1975.
2. Spectroscopy of Organic Compounds; Sixth Edition; P.S. Kalsi; New Age International (P) Ltd Publishers, New Delhi, 2004.
3. Polymers; David Walton and Philip Lorimer; Oxford Science Publication, 2000.
4. Introduction to Polymers; R.J. Young and P.A. Lovell; Nelson Thornes, United Kingdom, 2004.
5. Organic Spectroscopy; Third Edition; William Kemp; Palgrave, 2004.

Paper III : Introduction to Quantum Mechanics

Paper Code : CHY 503 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn principal concepts of quantum mechanics and establish relationship between physical properties and molecular structure.

I Atomic Structure **6 hrs**
Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids; Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect, De Broglie hypothesis, Heisenberg's uncertainity principle.

II Elementary Quantum Mechanics **5 hrs**
Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics.

III Applications of Quantum Mechanics **6 hrs**
Particle in one dimensional box; Schrodinger wave equation for H-atom, separation into three equations (without derivation); quantum numbers and their importance, hydrogen like wave functions, radial and angular wave functions.

IV Electronic Structure of Diatomic Molecules **7 hrs**
Molecular orbital theory, basic ideas- criteria for forming M.O. from A.O, construction of M.O's by LCAO (H_2^+ ion), calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of σ, σ^*, π, π^* orbitals and their characteristics; hybrid orbitals – sp, sp^2, sp^3, calculation of coefficients of A.O.'s used in these hybrid orbitals; introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

V Physical Properties and Molecular Structure **6 hrs**
Optical activity, polarization – Clausius-Mossotti equation, orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules.
Self Study: Magnetic properties-paramagnetism, diamagnetism and ferromagnetism

Books Recommended:
Text/References:

1. A Text Book of Physical Chemistry; A.S. Negi, S.C. Anand; New Age International (P) Limited, New Delhi, 2002.
2. Quantum Chemistry Including Molecular Spectroscopy; B.K. Sen; Tata McGraw-Hill, Publishing Company Ltd, New Delhi, 1996.
3. Introductory Quantum Chemistry; A.K. Chandra; Tata McGraw Hill Publishing Company Limited. New Delhi, 1998
4. Quantum Chemistry; R.K. Prasad; New Age International (P) Ltd., New Delhi, 2003.
5. Physical Chemistry Through Problems; S.K. Dogra and S.Dogra; Wiley Eastern Ltd, New Delhi, 2001.

Paper IV: Laboratory Course-V

Paper Code : CHY 504 **Max. Marks: 100**
Contact Hr./Week : 4 **(CA :30, SEE: 70)**
Credits : 2

Inorganic Chemistry **8 hrs**

Quantitative Analysis: Volumetric Analysis

a) Estimation of hardness of water by EDTA.
b) Estimation of ferrous (Fe^{+2}) and ferric (Fe^{+3})by dichromate method.

Organic Chemistry **32 hrs**

Qualitative Analysis

Separation and identification of solid binary mixture using water/$NaHCO_3$ /NaOH and preparation of suitable derivatives.

Physical Chemistry **20 hrs**

Colorimetry
Scan a spectra absorption curve of substance ($KMnO_4$/$K_2Cr_2O_7$) using a spectrophotometer and determine absorption maxima (λ_{max}).

Potentiometry
To titrate potentiometrically ferrous ammonium sulphate solution using $KMnO_4$/$K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe^{++}/Fe^{+++} system on the hydrogen scale.

Polarimeter
To determine the specific rotation of an optically active compound (glucose/sucrose)

Books Recommended:

Text/References:

1. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
2. Vogel's Textbook of Practical Organic Chemistry; Fifth Edition; B.S. Furniss, A.J. Hannaford, P.W.D. Smith, A.R. Tatchell; Addison-Wesley Longman Ltd., England, 1998.
3. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut,2005.

Semester VI

Paper I: Organometallics, Bio-inorganic and Inorganic Polymers

Paper Code : CHY 601 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn the structure and nature of bonding in metal carbonyls and nitrosyls, vitality of metal ions in biosystems and basics of organometallic chemistry.

I Organometallic Chemistry **7 hrs**

Definition, nomenclature and classification of organometallic compounds; general characteristics, preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti; metal ethylenic complex – Zeise's salt (brief idea). Hydrogenation and polymerization of alkene of transition metal complex (an elementry concept)

II Metal Carbonyls and Nitrosyls **6 hrs**

Introduction to π acceptor ligands; definition, classification, general methods of preparation, structure and nature of bonding in metal carbonyls (mononuclear carbonyls only).
Metal nitrosyls: preparation, structure and nature of bonding.

III Stereochemistry in Main Group Compounds **5 hrs**

$d\pi$-$p\pi$ bond, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

IV Bio-inorganic Chemistry **6 hrs**

The biological role of metal ions- Na, K , Ca, Mg, metalloporphyrins with special reference to haemoglobin and myoglobin; Na-K pump.

V Inorganic Polymers **6 hrs**

Types, comparison with organic polymers, synthesis, structural aspects and applications of silicones, phosphazenes, condensed phosphates and tetrasulphur tetranitride.
Self Study: Organic polymers

Books Recommended:
Text/References:

1. Organometallic Chemistry: A Unified Approach; Second Edition; R.C. Mehrotra and A.Singh; New Age International Private Limited, New Delhi, 2005.
2. Inorganic Chemistry; Third Edition; D.F. Shriver and P.W. Atkins; Oxford University Press, New York, 1999.
3. A Textbook of Inorganic Polymers; A.K. Bhagi and G.R. Chatwal; Himalaya Publishing House, Bombay, 2001.
4. Concepts and Models of Inorganic Chemistry; Third Edition Bodie Douglas, Darl McDaniel, John Alexander; John Wiley and Sons, Singapore, 2001.
5. Inorganic And Organometallic Polymers; Vadapalli Chandrasekhar, Springer, Berlin Heidelberg, New York, 2005.

Paper II: Nitrogen Containing Organic Compounds and Some Aspects of Medicinal Chemistry

Paper Code : CHY 602 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To introduce the students to the importance of nitrogen in organic compounds and chemotherapeutic agents.

I Heterocyclic Compounds **7 hrs**

Nomenclature of five and six membered heterocycles; molecular orbital picture and aromatic character of pyrrole and pyridine, comparison with furan and thiophene; methods of synthesis, chemical reactions; basicity of pyridine and pyrrole; electrophilic and nucleophilic substitution reactions in pyridine and pyrrole (mechanism and orientation).

II Condensed Five and Six Membered Heterocycles **5 hrs**

Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler – Napieralski synthesis.

III Nitroarenes **5 hrs**

Pre requisite: Aliphatic nitro compounds.

Preparation, reactions – electrophilic and nucleophilic substitution, effect of the substituents on the acidity of phenols, effect of nitro group on nucleophilic substitution of aryl halides, reduction.

IV Amines **6 hrs**

Pre requisite: Preparation and reactions of aliphatic and aromatic primary amines.

Classification and distinction between primary, secondary and tertiary amines; relative basic strength of aliphatic and aromatic amines; diazotization- mechanism, stability of diazonium salts, diazo coupling (mechanism) and its uses in the synthesis of acidic and basic azo dyes (methyl orange, methyl red, congo red, para red).

V Drugs and Antibiotics **7 hrs**

Introduction, lock and key theory.

Sulpha drugs: sulphadiazine, sulpha guanidine, sulpha methazine, sulpha pyridine and sulpha pyrimidine.

Analgesics: aspirin, phenacetin, paracetamol.

Antimalarials: chloroquine, pamaquine.

Antibiotics: penicillin, streptomycin and chloramphenicol.

Books Recommended:
Text/References:

1. Organic Chemistry; Fourth Edition; G. Marc Loudon; Oxford University Press, New York, 2002.
2. Organic Chemistry; Seventh Edition; T.W. Graham Solomons & Craig B. Fryhle; John Wiley and Sons, Inc. USA, 1998.
3. Organic Chemistry; Sixth Edition; Robert Thornton Morrison & Robert Neilson Boyd; Prentice-Hall of India Pvt. Ltd , New Delhi, 2004.
4. Organic Chemistry; First Edition; Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers; Oxford University Press, USA, 2001.
5. Organic Chemistry Vol. I & II; Fifth Edition; I.L. Finar; Longman Scientific and Technical, Singapore, 1975.

Paper III: Spectroscopy and Photochemical Laws

Paper Code : CHY 603 **Max. Marks: 100**
Contact Hr./Week : 2 **(CA :30, SEE: 70)**
Credits : 2

Objectives:
To learn principles of spectroscopy beneficial in applied sciences and research and the various processes involved during interaction of radiation with matter.

I Rotational Spectrum 6 hrs

Diatomic molecules, energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length; qualitative description of non-rigid rotor, isotope effect.

II Vibrational Spectrum 6 hrs

Infrared spectrum: energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.
Raman Spectrum: concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

III Electronic Spectrum 6 hrs

Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Franck–Condon principle, qualitative description of σ, π and n molecular orbital, their energy levels and respective transitions.

IV Nuclear Magnetic Resonance Spectroscopy 5 hrs

Introduction, principles of magnetic resonance, the energies of nuclei in magnetic fields, the technique, chemical shift, the fine structure – spin-spin coupling, applications(MRI).

V Photochemistry 7 hrs

Interaction of radiation with matter, difference between thermal and photochemical processes, laws of photochemistry- Grothus-Drapper law, Stark-Einstein law; Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing); quantum yield; photosensitized reactions-energy transfer processes (simple examples).

Books Recommended:
Text/References:

1. A Text Book of Physical Chemistry; A.S. Negi, S.C. Anand; New Age International (P) Limited, New Delhi, 2002.
2. Fundamentals of Molecular Spectroscopy; Fourth Edition; Colin N. Banwell and Elaine M. Mc Cash; Tata McGraw Hill, New Delhi, 2000.
3. The Elements of Physical Chemistry; P.W. Atkins; Oxford University Press, 1996.
4. Physical Chemistry Through Problems; S.K. Dogra and S.Dogra; Wiley Eastern Ltd, New Delhi, 2001.

Paper IV: Laboratory Course-VI

Paper Code : CHY 604 **Max. Marks: 100**
Contact Hr./Week : 4 **(CA :30, SEE: 70)**
Credits : 2

Inorganic Chemistry **22 hrs**

Quantitative Analysis: Instrumentation

Colorimetry

a) Detection of adulteration of food stuffs - To detect the total dye content in sunset yellow colour
b) Water analysis- analysis of phosphorus in water.

Solvent Extractions

Separation and estimation of Mg (II) and Fe (II).

Organic Chemistry **22 hrs**

Synthesis

a) Aromatic Electrophilic Substitution
i) Acetylation – Acetylation of aniline/salicylic acid.
ii) Nitration - Preparation of p-nitroacetanilide
ii) Bromination - Preparation of p-bromoacetanilide

b) Diazotization/coupling
i) Preparation of methyl orange

c) Hydrolysis (Acidic/Alkaline)
i) p-nitroacetanilide to p-nitroaniline
ii) p-bromoacetanilide to p-bromoaniline.

Physical Chemistry **16 hrs**

Colorimetry

To verify the Beer-Lambert Law for a compound (Potassium permanganate, copper Sulphate, methylene blue etc.) and determine the concentration of the substance using calibration curve.

Molecular Weight Determination

To determine the molecular weight of substance (urea/thiourea/glucose) using water as the solvent by Landsberger method.

Books Recommended:

Text/References:

1. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
2. Vogel's Textbook of Practical Organic Chemistry; Fifth Edition; B.S. Furniss, A.J. Hannaford, P.W.D. Smith, A.R. Tatchell; Addison-Wesley Longman Ltd., England, 1998.
3. Experimental Organic Chemistry, Volume I; P.R.Singh, D.S. Gupta, K.S. Bajpai; Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut,2005.

***