B.Sc. 3rd Year
Chemistry

Max. Marks: 75 ***Min. Marks: 27***
Internal Max: 25 ***Internal Min: 09***
Total Duration: (150 hours)

Section-A

Unit-I: Inorganic Chemistry-I (25 hours)

Transition Elements: Variation in atomic and ionic sizes , Ionization enthalpies , Variable oxidation states. Standard electrode Potentials of M^{2+} / M and M^{3+} / M^{2+} systems.

Ionic / Covalent and Acidic /Basic character of transition metal compounds in various oxidation states. Stabilization of unusual oxidation states.

Spectral and Magnetic Properties ; Calculation and uses of magnetic moment value.

Interstitial hydrides , carbides and oxides of first transition series :-Preparation , Properties & Uses.

Inner-Transition Elements: Electronic Configuration , Oxidation States , Magnetic Properties and Complexing behavour of inner transition elements.

Cause and Consequences of Lanthanoid / Actinoid Contraction.

Separation of Lathanoids: Fractional Crystallization , Ion–exchange and Solvent extraction methods.

Coordination Chemistry: Experimental verification of Werner's theory.Effective Atomic number: Concept and its significance.

Stereochemistry of Coordination compounds: With numbers (2-6); Optical and Geometrical isomers of MA_4B_2, MA_3B_3 and MABCD type Complexes.

Bonding in Complexes: Comparison of valence bond and Crystal field theories; CFT of tetrahedral, square planner and octahedral systems. Factors affecting magnitude of Δ ; pairing energy and CFSE of weak and strong field ligands.

Limitations of Crystal field theory. Applications of Coordination compounds.

Unit-II: Inorganic Chemistry-II (25 hours)

Bio-inorganic Chemistry: Bimolecules and their Metal coordination behaviour: Proteins, Nucleic acid and Lipids.

Abundance of elements in living systems; Concept and Criteria for essentiality of elements in living systems.

Distribution and biological role of essential elements in life: Na^+, K^+, Ca^{2+}, Mg^{2+}, Fc^{2+} and halogens.

Hemoglobin & Myoglobin: Structure and Biological role.

Quantitative Analysis: Gravimetry : -Definition , Preparation of standard solution and precipitation methods.

Physical properties of precipitates: Appearance, particle size and purity; Fractional precipitation.

Colloidal State: Supersaturation, Precipitate formation, Co-precipitation and Post– precipitation; Digestion, Washing, Ignition and Gravimetric Calculations.

Titrimetry: Definition , Types , Primary and Secondary standard substances and preparation of standard solutions.

Indicators: Types , Criteria of selection , Mechanisms of action (Acid base and Redox) . Theory of visual titration of acids and bases.

Precipitation Titrations: Underlying principles and detection of equivalence points (Mohr, Volhard, Fajan's and Nephelometric methods).

Redox Reagents: Their equivalent weights, Redox potentials and applications in Volumetric Analysis.

Data Evaluation: Accuracy and precision , Types of errors ; Mean and standard deviations.

Section-B

Unit-III: Organic Chemistry-I (25 hours)

Ultraviolet Spectroscopy:- The electromagnetic spectrum. Beer-Lambert law, molar absorptivity, presentation and analysis of electronic spectra. Types of electronic excitations. Effects of conjugation and solvents on absorption. Chromophores and auxochromes. Bathochromic and hypsochromic shifts. Ultraviolet spectra of enes and enones. Prediction of maxima of enes and enones using Woodward's rules.

Infrared spectroscopy: The infrared region, Molecular vibrations, significance of Hook's law and selection rules. The infrared spectrum. Fingerprint region and its significance. Effect of resonance, inductive effect and H-bonding on infrared absorptions. Characteristic absorptions of Alkanes, alkenes, alkynes, alcohols, ethers, carbonyl compounds, amines and carboxylic acids and their derivatives.

Nuclear Magnetic Resonance Spectroscopy: Basic principles of NMR spectroscopy. Shielding and deshielding of protons. The chemical shift. Equivalent and non-equivalent protons. Spin-spin splitting, coupling constants for vicinal, geminal and long range couplings. The NMR spectra of ethyl bromide, ethanol, acetaldehyde, ethyl acetate, methyl propionate, toluene and acetophenone.

Unit-IV: Organic Chemistry-II **(25 hours)**

Carbohydrates: Introduction, classification, D&L-system of nomenclature, and cyclisation of monosaccharides. Determination of ring size of D-glucose. Mechanisms of formation of osazones, glycosides, acetates and methyl ethers of monosacchrides. Chain lengthening and shortening processes of aldoses. Mechanism of mutarotation. Chemistry of sucrose, maltose and lactose.

Amino acids / Peptides: Introduction, classification, structure and stereochemistry of amino acids. Acid-base behaviour and isoelectric points. Methods of formation and reactions of alpha-amino acids. Structure determination of dipeptides through end group analysis and selective hydrolysis and their classical and solid phase syntheses.

Proteins: Primary, Secondary, Tertiary and Quaternary structures of proteins.

Lipids: Definition and classification. Structural features of triglycerides. Common fatty acids in naturally occurring fats and oils. Saponification, iodine and acid values and their significance. Soaps and detergents.

Steroids: Introduction. Structural features and nomenclature of cholesterol, androsterone, oesterone, progesterone and cortisone.

Secondary metabolites: Introduction, classification and importance of Terpenoids and Alkaloids. Structural features of representative examples from each class.

Section-C

Unit-V: Physical Chemistry-I **(25 hours)**

Quantum Chemistry:

Limitation of Classical mechanics: Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids and atomic spectra. Sinosoidal wave equation. Introduction to operators. Linear and Hermitian operators, Hamiltonian operator, commutation of operators. Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, detailed treatment of particle in a 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. Molecular orbital theory; basic ideas, criteria for forming M.O's from AO's. Construction of M.O's by LCAO, H_2^+ ion(expressions for bonding and antibonding MOs and their energies), physical picture of bonding and antibonding wave functions, concept of σ, σ^*, π and π^*orbitals and their characteristics.

Spectroscopy: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers. Statement of Born-Oppenheimer approximation.

Rotational spectrum: Moment of inertia, classification of molecules on the basis of moment of inertia. Energy of a rigid diatomic rotor, selection rules for rotational transition and associated spectrum, relative population of rotational levels and spectral intensity, determination of bond length.

Vibrational Spectrum: Classical and quantum mechanical (qualitative) treatment of simple harmonic oscillator, selection rules for vibrational transition, pure vibrational spectrum of a diatomic molecule, determination of force constant, relation of force constant with bond length and bond energy, vibrational degrees of freedom, idea of vibrational frequencies of different functional groups.

Unit-VI: Physical Chemistry-II (25 hours)

Photochemistry: 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).

Kinetics of photochemical reactions: Photochemical decomposition of hydrogen iodide. Hydrogen-chlorine and hydrogen-bromine reactions.

Thermodynamics of Solutions: Thermodynamics of elevation in .boiling point and depression in freezing point. Activity and activity coefficient, determination of activity and activity coefficient with freezing point and emf methods. Excess thermodynamic functions of non-ideal solutions.

Dielectric properties of matter: Dipole moment and induced dipole moment. Measurement of dipole moment (temperature and refractivity methods), dipole moment and structure of molecules. Polarization-(Clausius-Mossotti equation) orientation of dipoles in an electric field. Piezoelectricity, pyroelectricity and ferroelectricity.

Books Recommended:

1. Coordination Chemistry; D.Banerjee ; Tata Mc Graw Hill, 1997.
2. Concise Coordination Chemistry ; R. Gopalan & V. Ramalingam ; Vikas, 2003.
3. Basic Inorganic Chemistry; F.A. Cotton. G. Wilkinson & P.L. Gauss ; Wiley, 3rd edn., 2002.
4. Inorganic Chemistry ; D.E Shriver; P.W. Atkins & C.H. Langford ; Oxford, 4th edn., 2006.
5. Concise Inorganic Chemistry ; J.D. Lee. ELBS, 5th edn., 2003
6. Inorganic Chemistry ; Gary Wulfsberg ; Viva; 1st edn., 2005.
7. Concepts and Models of Inorganic Chemistry ;.; B.Douglas ; D.McDaniel ; J. Alexander; Wiley ; 3rd edn 2001.
8. The Biological Chemistry of Elements ; J.J. R. Frausto de Silva & R.J.P. Williams ; Oxford; 1994
9. Bio Inorganic Chemistry of Elements ; K. Hussain Reddy ; New Age ; 2005.
10. Metal ions in Biochemistry; P.K. Bhatacharya; Narosa ; 2005.
11. Vogel's Text of Quantitative Inorganic Analysis; J. Bassett ; R.C. Denny ; ELBS, 6th edn., 2007.
12. Analytical Chemistry; G.D. Christian; 5th edn. ; Wiley ; 2001
13. Organic chemistry; Vol I & II; 31st edn. ; I.L.Finar ; LPE, Pearson Education.
14. Organic chemistry ; Morrison and Boyd ; Prentice Hall, 6th edn., 2003.
15. Organic chemistry; I.G.Wade ; Prentice Hall, 5th edn., 2004.
16. Fundamentals of Organic chemistry ; 5th edn. ; Solomons ; John-wiley.
17. Organic chemistry ; Vol I, II & III ; Singh ; Mukherji & R. P. Kapoor ; Wiley-Eastern .
18. Text book of Organic Chemistry ; R.K.Bansal ; Wiley- Eastern ; 4th edn., 2003
19. Advanced Organic Chemistry ; B.S.Bahl and Arun Bahl ; (S.Chand ; 1996.
20. Physical chemistry; P.W. Atkins; Oxford, 9th edn., 2011.
21. Physical Chemistry- A Molecular Approach ; D.A. McQuarrie and J.D. Simon ; VIVA,2008
22. Physical Chemistry; G. M. Barrow, McGraw-Hill ;International Student edition, 5th edn., 1992.
23. Physical Chemistry; R. A. Alberty, John Wiley, 1st edn., 1995.
24. Essentials of Physical Chemistry ; Vols III & IV; K. L. Kapoor; Macmillan India Ltd, 2nd edn., 2005
25. Principals of Physical Chemistry; Puri, Sharma and Pathania ; S. Nagin Chand & Co., 44th edn., 2011.
26. Physical Chemistry through Problems; S. K. Dogra ; Wiley Eastern Ltd,1991.
27. Introduction to Quantum Chemistry ; A. K. Chandra ; TMH, 4th edn., 2004.
28. Molecular Spectroscopy ; C. N. Banwell ; TMH, 4th edn., 2005.

Laboratory Course

Max. Marks: 25 ***Min. Marks: 09***
Internal Max: 25 ***Internal Min: 09***

A. Inorganic Chemistry

1. Synthesis:

a) Preparation of sodium trioxalato ferrate (III), $Na_3[Fe(C_2O_4)_3]$.

b) Preparation of Ni – dmg complex - $[Ni(dmg)_2]$.

c) Preparation of copper tetraamine complex $[Cu(NH_3)_4]SO_4$

2. Spectrophotometery:

a) Spectrophotometric determination of Fe (II), using 1, 10-Phenanthroline

b) Spectrophotometeric determination of Cu (II) with EDTA.

3. Paper Chromatography:

Separation and identification of metals from mixtures containing two Cations –two exercises

B. Organic Chemistry

1. Chromatography:

a) Thin layer Chromatography

i. Preparation & separation of 2,4 – dinitro phenylhydrazones of acetone, 2– butanone using toluene and pet-ether (60:40).

ii. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5 : 1.5)

b) Column Chromatography

Separation and identification of fluorescin and methylene blue.

2. Analysis of Organic mixture containing two solid components using H_2O, $NaHCO_3$ and NaOH for separation.

3. Synthesis of Organic Compounds (Any three single stage preparations e.g.)

a) Acetylation of Salicylic acid

b) Preparation of Iodoform from acetone.

c) Preparation of m-dinitrobenzene from benzene.

d) Preparation of p-bromo acetanilide from acetanilide.

C. Physical Chemistry

b) To determine the strength of the given acid conductometrically using standard alkali solutions.

c) To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.

d) pH – metry , To deterimen pka of a weak acid by pH metry

Refractometry

a) To determine refractive index of a liquid by using Abbe's refractometre.
b) To determine percentage composition of a mixture of two liquids by refractometry (Glycerol and water).

Molecular Weight Determination

Determination of molecular weight of a non-volatile solute by Rast method and Beckman freezing point method.

Books Suggested:

1. Vogel's text book of Quantitative Inorganic Analysis (revised) , J. Bassett, R.C. Denney, G. H Jeffery and J. Mendham , ELBS, 6th edn., 2007.
2. Experimental Inorganic Chemistry , W.G. Palmer , Cambridge.
3. Handbook of preparative Inorganic Chemistry , Vol. I & II , Brauer , Academic Press.
4. Experimental Organic Chemistry Vol I & II , P.R. Singh , D.S. Gupta and K.S. Barpal Lata McGraw Hill.
5. Laboratory manual in Organic Chemstry , R.K. Bansal , Wiley Eastern.
6. Vogel's Textbook of practical Organic Chemistry , B.S. Furniss , A.J. Hannaford , V. Rogers , P.W.G Smith and A.R. Tatchell, ELBS, 5th edn., 2009.
7. Experiments in Physical Chemistry , R. C Das and B. Behra , Tata McGraw Hill.
8. Advanced Practical Physical Chemistry , J.B. Yadav, Goel Publishing House, 20th edn., 2001.
9. Advanced Experimental Chemistry, Vol. I-Physical , J.N. Gurtu and R. Kapoor , S. Chand & Co, 2000.