SEMESTER – I

Ch-101: INORGANIC CHEMISTRY- I

52h

UNIT- I **13h**

Chemical Bonding- VSEPR model, shapes of molecules-ClF_3, ICl_4^-, TeF_5^-, I_3^-, $TeCl_6^{2-}$, XeF_6, $SbCl_6^{3-}$, IF_7, ReF_7, XeF_8^{2-}, TaF_8^{3-}; Bent rules and energetics of hybridization; electronegativity- Pauling, Allred-Rochow and Mulliken, electronegativity and partial ionic character; Bonds- Multicenter, Synergic and Agostic bonding. Lattice energy: Born-Lande equation, Kapustinskii equation; Fajan's rules- polarizability and partial covalent character, radius-ratio rules-limiting radius ratios of trigonal, tetrahedral, octahedral and cubic. Structures of solids-NaCl, CsCl, ZnS(zinc blende and wurtzite), rutile(TiO_2), pervoskite($CaTiO_3$), fluorite and anti fluorite. Zintl ions, Molecular orbital theory: formation of sigma, pi and delta bonds, LCAO and MO diagrams of heteronuclear diatomic (CO, NO, HF and ICl) and triatomic molecules (CO_2 and NO_2^-).

UNIT- II **13h**

Chemistry of main group elements:- Boranes- nomenclature, synthesis, structure and bonding in boranes, styx code, carboranes- classification, structures of ortho, meta, para-$C_2B_{10}H_{12}$, Wades rules, Metallocarboranes- synthesis and structure of $[Fe(\eta^5\text{-}C_2B_9H_{11})_2]^{2-}$, $Fe(\eta^5\text{-}C_2B_9H_{11})(\eta^5\text{-}C_5H_5)$, $[Mo(CO)_3(\eta^5\text{-}C_2B_9H_{11})]^{2-}$, synthesis, structure and bonding in borazine, phosphazenes- synthesis, structure and bonding in $(PNCl_2)_3$, S,N- compounds- S_4N_4, S_2N_2 and polythiazyl.

Silicates:- Principles of silicates structures, classification with examples-ortho, pyro, cyclo, ino, phyllo and tecto silicates, isomorphous replacement; zeolites- sodalite and pentasil units, synthesis and structures of ZSM-5, zeolite A, faujasite and their uses.

UNIT-III **13h**

HSAB concept: Basis of HSAB concept, acid-base strength, hardness and softness, symbiosis, applications and limitations of HSAB concept; Acid- base concept in non-aqueous media, reactions in BrF_3, N_2O_4, anhydrous H_2SO_4, CH_3CO_2H. Isopoly and heteropoly acids of W and Mo, preparations, properties, structure and applications.

Stereoisomerism:- Chirality, optical activity- CD, ORD, Cotton effect, absolute configuration of
metal complexes, magnetic circular dichroism and its uses.

UNIT-IV **13h**

Metal clusters- factors favouring M-M bond, classification, synthesis, structure and bonding in $[Re_2Cl_8]^{2-}$. Metal carbonyl clusters- LNCC's and HNCC's. Electron counting in carbonyl clusters, Wades-Mingos and Lauher rules.

Nuclear Chemistry-The atomic nucleus-elementary particles, quarks, classification of nuclides based on Z and N values, nuclear stability, nuclear potential, binding energy. Nuclear

Models: Shell model-salient features, forms of the nuclear potential, filling of orbitals, nuclear configuration, Liquid drop model. Radioactivity, radioactive decay kinetics, Parent-daughter decay-growth relationship-secular and transient equilibria, theories of α, β^-, β^+ and γ-decay, internal conversion, Auger effect.

SUGGESTED BOOKS

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 3rd edition (2004).
2. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson. 6th edition (1999).
3. Inorganic Chemistry, J. E. Huheey, E. A. Keiter and R. L. Keiter, IV edition Addison; Wesley (1993).
4. Inorganic Chemistry, D. F. Shriver, P. W. Atkins and C. H. Langford, V edition ELBS; Oxford University Press, (2010)
5. Chemistry of elements; N. N. Greenwood and A. E. Earnshaw, Butterworth, II edition Heinemann (1997).
6. Concise Inorganic Chemistry, J. D. Lee , 5th edition; (1996).
7. Essentials of nuclear chemistry, H. J. Arniker, 4th edition; NAIL publishers (2011) Chapters 1, 3 and 4.
8. Nuclear and Radio chemistry; G.Friedlander, J.W.Kennedy, ES Macias and JM Miller; 1981, Chapters 8and 9.
9. Inorganic Chemistry, Gary. L. Miessler and Donald . A. Tarr 5th Edition; (2014).
10. Inorganic Chemistry CE House croft and A G Sharpe 4th edition, pearson (2012).

Ch-102: ORGANIC CHEMISTRY- I

52h

UNIT-I

Nature of Bonding in Organic Molecules **13h**

Delocalized chemical bonding: Conjugation, cross conjugation, resonance. Hyperconjugation. Tautomerism.

Aromaticity: Huckel's MO theory. HMO diagram for benzene. Huckel's rules of aromaticity. Aromatic systems with electron numbers other than six (including azulene, tropone, tropolone and annulenes). Anti-aromaticity. Aromaticity in benzenoids. Homo-aromaticity. Alternant and non-alternant hydrocarbons. Energy levels in odd and even-alternant hydrocarbons, energy levels for the benzyl cation, benzyl free-radical and benzyl carbanion.

Mesoionic compounds. Heteroannulenes. Fullerenes: C-60.

Synthetic Molecular Receptors: Definition and significance. Structure and function of receptors with molecular clefts, molecular tweezers, receptors with multiple hydrogen bonding sites. Crown ethers, cryptates, cyclodextrins, cyclophanes, catenanes and rotoxanes, calixarenes, ionophores and micelles.

UNIT-II

Reaction Mechanisms: **13h**

Reactive intermediates: Generation, structure, stability and reactivity of carbocations, carbanions, carbon free radicals, carbenes. Non-classical carbocations, nitrenes.
Reactions and mechanisms: Thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates.
Methods of determining mechanisms: Based on the structure of products, determination of the presence of intermediates, isotopic labeling, isotope effects, from stereochemical evidence.
Acids and bases: Hard and soft acids and bases. Effect of structure on the strengths of acids and bases.
Effect of structure on reactivity: Resonance and field effects; steric effects. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.
Aliphatic substitution reactions:
Nucleophilic substitution reaction at a saturated carbon: SN1, SN2, and SET mechanisms. Effect of substrate structure, attacking nucleophile and leaving group. Neighbouring group participation by sigma and pi bonds. Anchimeric effect. Ambident nucleophiles and substrates.
Electrophilic substitution reaction at a saturated carbon: SE1, SE2, and SEi mechanisms. Effect of substrate structure, leaving group and solvent polarity on the reactivity.

UNIT-III

Stereochemistry **13h**

***Projection formulae*: Fischer, Newman, Sawhorse and flying wedge projections - their interconversions for acyclic and cyclic compounds.**
Conformational analysis: D/L, R/S and M/P conventions. Cahn-Ingold Prelog (CIP) sequence rules.
Optical isomerism: Elements of symmetry and chirality. Chirality in compounds with a stereogenic centre. Center of chirality, axis of chirality, plane of chirality and helicity. Stereochemistry of allenes, alkylidene cycloalkanes and spiranes (with a stereogenic axis), biphenyls, cyclophanes, ansa compounds, *trans*-cyclooctene, helicenes, benzphenanthrenes. Configurational nomenclature.
Conformational analysis: Conformational analysis of cycloalkanes: cyclobutane, cyclopentane, cyclohexanes (mono-substituted e.g., methyl, *iso*-propyl, *tert*-butyl and di-substituted cyclohexanes e.g., dialkyl-, dihalo-, diols), and cycloheptane.
Nomenclature and conformations of fused rings and bridged ring systems.
Prochirality: Enantiotopic and diastereotopic atoms, groups and faces. [Si/Re]. Basics of Cram's and Prelog's rules of asymmetric induction.

UNIT-IV

Carbohydrates: **13h**

Introduction. Determination of configuration of the mono saccharides, conformational analysis of monosaccharides. Synthesis of aldonic, uronic, aldaric acids and alditols. Derivatives of monosaccharides: acetals, ethers, aminosugars and deoxysugars. Structural elucidation of sucrose and maltose. Structures of lactose, gentiobiose and meliobiose. Photosynthesis of carbohydrates.

Heterocyclic compounds:

Introduction. Nomenclature of simple and fused heterocyclic compounds. Synthesis and reactions of pyrazole, imidazole, oxazole, isoxazole, thiazole and isothiazole. Synthesis of benzimidazole, benzoxazole, benzisoxazole, indole and coumarins.

Vitamins

Introduction. Biological importance and synthesis of Vitamin A, Vitamin B_1 (thiamine), Vitamin B_6 (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (α-tocopherol), Vitamin H (biotin), Vitamin K_1 and K_2.

SUGGESTED BOOKS

1. Organic Chemistry, R T Morrison, R N Boyd and S K Bhattacharjee, 7th edition, Pearson, (2018).
2. Organic Chemistry, J Clayden, N Greeves and S Warren, 2nd edition, Oxford University Press, (2014)
3. Advanced Organic Chemistry – Reactions, Mechanism and Structure, J March, John Wiley (2008).
4. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum, (2000).
5. A Guide Book to Mechanism in Organic Chemistry, P Sykes, 6th edition, Pearson, (2003).
6. Structure and mechanism of Organic Chemistry, C K Ingold, 2nd Edition, CBS, (2016).
7. Principles of Organic Synthesis, 3rd edition, R O C Norman and J M Coxon, Blackie Academic and Professional (Indian Reprint), (2012).
8. Stereochemistry, V R Dani, Asian Books, New Delhi, (2014).
9. Stereochemistry of Organic Compounds, D Nasipuri, 3rd edition, New-Age International, (2018).
10. Organic Stereochemistry, M J T Robinson, Oxford University Press, (2005).
11. Stereochemistry of Carbon Compounds, E L Eliel, S H Wilen and L N Mander, John Wiley, (1994).
12. Stereochemistry at a Glance J Eames, J M Peach, Blackwell, Oxford, (2003).
13. Heterocyclic Chemistry at a Glance, II edition, J A Joule and K Mills, Wiley, New York, (2012).
14. Organic Chemistry, Volume I, I L Finar, 6th edition, Pearson, (2018).
15. Organic Chemistry, Volume II, I L Finar, 6th edition, Pearson, (2018

Ch-103: PHYSICAL CHEMISTRY- I

52hr

UNIT-I

Quantum Mechanics-I **13h**

Introduction to quantum mechanics. Schrödinger wave equation. Time-independent and time dependent Schrödinger wave equations and the relation between their solutions. Eigen functions and Eigenvalues. Physical Interpretation of wave function. Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Angular Momentum operators and their properties. Commutation of operators. Normalization, orthogonality and orthonormality of wave functions. Average (expectation) values. Postulates of quantum mechanics. Solutions of Schrödinger wave equation for a free particle, particle in a ring, particle in a three dimensional box. Quantum mechanical degeneracy, tunneling (no derivation). Application of Schrödinger equation to harmonic oscillator, rigid rotator. Eigen functions and eigenvalues of angular momentum. Ladder operator method for angular momentum.

UNIT-II

Quantum Mechanics-II **13h**

Schrödinger equation to hydrogen atom in spherical polar co-ordinates. Solution of equation and statements of solution of R equation. Total wave functions of hydrogen atom. Quantum numbers and their characteristics. List of wave functions for few initial states of hydrogen like atoms. Diagrams of radial and angular wave functions. Radial and angular distribution function and their significance. Electron spin

(Stern-Gerlach experiment), spinorbital, anti symmetry and Pauli-exclusion principle, Slater determinants. Coupling of Angular momenta. Russell-Saunders and JJ-coupling, Atomic Term symbols. Spin-orbital interaction and explanation of term multiplicities (Na-D doublet). Zeeman effect.

Approximate methods: Need for approximate methods. Perturbation method. Rayleigh Schrödinger perturbation theory for time-independent non-degenerate system. Application to electron in a box under the influence of an electric field. Application to He atom. Variation theory-statement and proof. Application of variation method to particle in a one-dimensional box and He atom.

UNIT-III

Chemical Dynamics-I **13hr**

Macroscopic and microscopic kinetics, Review of theories of reaction rate-Collision theory and Transition state theory, Comparison of collision theory with transition state theory, Arrhenius equation- characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Thermodynamical formulation of reaction rates (Wyne-jones and Eyring treatment), Reaction between ions in solutions – Influence of ionic strength on reaction rates (primary and secondary salt effects).

Concept of Steady state kinetics, Chain reactions – chain length and chain inhibition, comparison of photochemical and thermal reactions, Mechanisms of thermal and photochemical

reactions between hydrogen-bromine and hydrogen-chlorine. Comparative study of thermal and photochemical hydrogen-halogen reactions. Pyrolysis of acetaldehyde, Decomposition of ethane.

Kinetics of fast reactions- Introduction, Study of reactions by relaxation method (Temperature and pressure jump), flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method.

UNIT-IV

Chemical Dynamics-II **13hr**

Kinetics of homogeneous catalysis: kinetics of auto catalytic reactions, kinetics of acid-base catalysed reactions. Comparison of enzyme catalysed and chemical catalysed reactions, Mechanism (Lock and Key theory), Kinetics of enzyme catalyzed reactions – Henri-MichaelisMenten mechanism, Significance of Michaelis-Menten constant, Lineweaver-Burk plot. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity.

Unimoleuclar reactions: Perrin theory, Lindemann theory, and Hinshelwood theory.

Surface chemistry: Types of adsorption isotherms, Effect of temperature on adsorption, Mechanical adsorption, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its significance, Surface tension and surface energy, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena), Catalytic activity of surfaces.

SUGGESTED BOOKS

1. Physical Chemistry- P. Atkins and J. D. Paula, 9th Edn., Oxford University Press (2010).
2. Physical Chemistry: A Molecular Approach,D. A.McQuarie and Simon, Viva, New Delhi, (2003).
3. Introduction to Quantum Chemistry, A. K. Chandra, 3rdEdn. Tata McGraw Hill, (1991).
4. Quantum Chemistry, Ira. N. Levine, Prentice Hall, New Jersey, (1991).
5. Quantum Chemistry, R. K. Prasad, New Age International, 4thEdn., (2010).
6. Quantum Mechanics by G R Chatwal and S K Anand, Himalaya Publications, 8thEdn, 2012.
7. Chemical Kinetics- K. J. Laidler, McGraw Hill. Inc. New York (1988).
8. Principles of Chemical Kinetics – House J. E. Wm C Brown Publisher, Boston, (1997).
9. Kinetics and Mechanism of Chemical Transformations- J. Rajaraman and J. Kuriakose, Mc Millan India Ltd. (2011).
10. Biochemistry, - Geoffrey Zubay, 2nd Edn., Macmillan Publishing Co. New York (1988).
11. Physical Chemistry of Surfaces- A. W. Adamson, Wiley-Interscience Publisher Inc., New York (1997).
12. Introduction to surface chemistry and Catalysis by Gabor A. Somorjai and Yimin Li, John 2ndEdn. Wiley and Sons Ltd, Hoboken, United States, 2010.

Ch-104 : ANALYTICAL CHEMISTRY

UNIT – I

Basic concepts **13 h**

Safety measures in chemical laboratories, Fire hazards, toxic chemicals: Acids/bases/solvents handling, storage, dilution, disposal of chemicals, acid/ solvent bottles etc. toxic chemicals sampling and handling hazards, safety data sheets, miniaturization of analytical instruments, their significance in modern chemical analysis.

Preparation of dilute acids from concentrated/fuming acids like H_2SO_4, handling liquid bromine, elemental mercury, solvent ether, liquor ammonia,liquid nitrogen.

Errors in chemical analysis: absolute, relative error, random error distribution, Gaussian curve, Limitations of analytical methods, determinate and indeterminate errors, minimization of errors. Accuracy and precision, distribution of random errors, the normal error curve. Statistical treatment of finite samples - measures of central tendency and variability: mean, median, range, standard deviation, variance, confidence limits, Comparison of an experimental mean and a true mean. F-test, rejection of result - Q-test, Student's t-test, numerical problems.

UNIT-II

Quantitative Analysis-Classical methods **13 h**

Classification of analytical methods, types of instrumental analysis, factors influencing choice of analytical method, qualitative and quantitative analysis, Units used in chemical analysis,their conversion, ppm, ppb, ppt etc.

Titrimetry

Acid-Base: Theory of indicators, Ex: Phenophthalien, Methyl red. Titration curves for mono functional acid and base, pH calculations, fractions of phosphoric acid species as a function of pH. Titration curves for H_3PO_4.

Complexometry: Theory of metal ion indicators, EDTA titrations, suitability of polydentate ligands as titrants, expressions for the different forms of EDTA in solution as a function of pH, conditional stability constants, effect of pH and nature of titration curve. Masking and demasking, type of EDTA titrations, titrations involving monodentate, bidentate and polydentate ligands.

Redox: Mechanism of indicator action, criteria for the selection of indicators. Feasibility of redox titration. Titration of multicomponet system. Nernst equation. Applications: Oxidants such as Ce(IV), bromate, Iodates.

Precipitation: Solubility product. Theoretical principles of precipitation: Titration curve, end point detection, Mohr, Volhard and adsorption indicators. Applications: Estimation of F^-, K^+, CO_3^{2-}, $C_2O_4^{2-}$, acetylenes and mixture of halides.

Gravimetry

Quantitative precipitation, *Precipitation from Homogeneous Solution (PFHS)*, Formation and treatment of precipitates, co-precipitation, post precipitation. Conditions for precipitation, washing, drying and igniting the precipitates, Important precipitating agents such as DMG, oxine, thiocyanate and their significance in inorganic analysis. errors in gravimetric analysis.

Unit-III

13h

Quantitative Analysis – Instrumental methods

Electromagnetic radiation, interaction with matter, absorption, Beer-Lambert's law, derivation, molar absorptivity, Sandell sensitivity, Ringbom plot, deviations, limitations, Calibration with standards, standard addition, internal standard addition, limit of detection, limit of quantification, Instrumentation, radiation sources, wavelength selection devices, optical slits, single beam and double beam instruments, photo electric colorimeter, scanning devices, merits and limitations, numerical problems on application of Beer's law.

Unit IV

13h

Separation Methods

Solvent Extraction – Types ,batch, continuous, efficiency, selectivity. Distribution coefficient, Nernst distribution law, derivation, factors affecting the partition, applications. Chromatography – Types, Terminology, Principles of paper, thin layer, column, gas chromatography, column efficiency, plate theory, factors affecting the column efficiency, band broadening, R_f factor, Van-Deemter equation, medium performance liquid chromatography, high performance liquid chromatography, reserved phase liquid chromatography, super critical fluid chromatography, characteristics of super critical fluids, 2D-thin layer chromatography, electrophoresis, principles, applications etc. numerical problems on solvent extraction, Rf factor and van Demeter equation.

SUGGESTED BOOKS:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York, 2005.
2. Analytical Chemistry, G.D. Christian, 6th edition, John Wiley & Sons, Inc, India, 2004.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, Prentice Hall, Inc. New Delhi, 1993
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, Pearson Education Pvt. Ltd., New Delhi, 2003.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, Blackwell Sci., Ltd. Malden, USA, 2000.
7. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
8. Practical Volumetric Analysis, Peter A C McPherson, RSC, Cambridge, UK, 2015.
9. Analytical Chemistry for Technicians, John Kenkel, 4th edn. CRC Press, London, 2014.
10. Undergraduate Instrumental Analysis, J.W. Robinson, E.M. Skelly Frame, G. M. Frame II, 6th edn. Marcel Dekker, New York, 2009.

Ch-105: MATHEMATICS FOR CHEMISTS

UNIT-I

12h

Vectors: vectors, dot and cross products; scalar and vector triple products and their applications. Tensors and their applications.

Matrix Algebra: Review of different types of matrices (including Hermetian and skew Hermetian); matrix addition and multiplication; determinant of a square matrix, transpose, adjoint and inverse of a square matrix. Solution to system of linear equation (a) by matrix method and (b) by Cramer's Rule. Characteristic equation of a square matrix, eigenvalues and eigenvectors.

UNIT-II

12h

Calculus: Rule for differentiation; Chainrule (for $f(x)=U^n$, sin u,logu etc). Implicit differentiation and parametric differentiation and successive differentiation of order 2 (for explicit functions only).

Applications of differentiation: Derivative as a slope of the tangent, derivative as a rate measure-velocity and acceleration. Increasing and decreasing functions-Maxima and minima-second derivative test-point of inflections-problems restricted to polynomial.

UNIT-III

12h

Integrations: Basic rules-simple substitution-Method of partial fractions-Integration by parts. Define integral and application to areas of plane curves.

Functions of several variables: partial derivatives; co-ordinate transformation from cartesian co-ordinates to spherical and cylindrical coordinates and vice-versa.

Elementary differential equation: Variable separable, exact first order equations, linear and homogeneous equation.

Second order homogeneous differential equation with constant coefficients f(D), y=0. Solution of differential equation by power series method.

Fourier series: Simple problems.

Probability: Review of permutations and combinations. Probability and addition theorem for mutually exclusive events and multiplication theorem for independent events. Curve fitting-Method of least squares.

SUGGESTED BOOKS

1. Mathematical Preparation for physical chemistry, F. Daniells, M.Graw Hill Inc., US, 1959.
2. Mathematics for chemists, D. M. Hirst, Chemical Publishing Company Incorporated, New York, 1979.
3. Mathematics for chemists, P. G. Francis, Springer, 2011.
4. Basic Mathematics for chemists, P. Tebutt, Wiley-Blackwell, 1994.
5. Calculus and analytic geometry, 9th edition, G. B. Thomas, R.L. Finney, Addison-Wesley Publishi Company, Inc. 1996.
6. Short Course in differential equations, Rainvilles and Bedient, IBH publishers, 1968.

7. Mathematics for chemistry, G. Doggett and B. T. Sutcliffe Longmann Publishers, 1995.

INORGANIC CHEMISTRY PRACTICALS
(4 days a week, 4 hours a day)

C-106 : Inorganic Practical-I (Semi-micro Qualitative Analysis)

Semi micro qualitative analysis of mixtures containing two anions, two common cations and one less familiar elements: W, Mo, Ce, Zr, V and Li.

C-107: Inorganic practical-II (Complex preparation)

Preparation of inorganic complexes:
1. Cis- potassium dioxalatodiaquachromium(III) complex.
2. Hexamminecobalt(III) chloride.
3. Mercury tetrathiocyanatocobaltate.
4. Pentamminechlorocobalt(III) chloride.
5. Potassium tris(oxalato)ferrate trihydrate.
6. Potassium tris(oxalato)aluminate trihydrate.

C-108: Inorganic Practical-III (Gravimetry)

Gravimetric analysis
1. Determination of Fe in iron ore as Fe_2O_3.
2. Determination of Ni as nickel dimethylglyoximate in Cu and Ni solution.
3. Determination of Ca as $CaC_2O_4.H_2O$.
4. Determination of Al as aluminiumoxinate.
5. Determination of Cu as CuSCN in Cu and Fe solution.
6. Determination of Zn as $ZnNH_4PO_4$.

C-109 :Inorganic Practical-IV (Volumetry)

Volumetric analysis
1. Determination of Ca and Mg in Dolomite solution using EDTA.
2. Determination of Cu in Cu and Ni solution iodometrically.
3. Determination of Fe in Cu and Fe solution (using $K_2Cr_2O_7$).
4. Determination of Cr and Fe in a mixture using ceric ammoniumsulphate.
5. Determination of Fe and Al in mixture using EDTA.
6. Determination of percentage of Fe and oxalate in $K_3Fe(C_2O_4)_3.3H_2O$

SUGGESTED BOOKS

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, 7th edition, ELBS (2013).
2. Vogel's text book of Quantitative Chemical Analysis, 6th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, J D Barnes, M.Thomas Prentice Hall (2000)
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1990).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co.,

London (1972).
5. An Advance course in practical chemistry, A Ghoshal, B Mahapatra and A K Nad; New central book agency Pvt.Ltd. 3rd eidition 2007.
6. Advanced inorganic analysis, S K Agarwal and Keemtilal; Pragati prakashan, 12th edition 2014.

ORGANIC CHEMISTRY PRACTICALS

(4 days a week, 4 hours a day)

Ch-106 : Organic Practical-I (Preparation –One stage)

Preparation (one stage)

1. Oxidation of cyclohexanol.
2. Preparation of S-benzylisothiuroniumchloride.
3. Synthesis of picric acid.
4. Synthesis of glucose pentaacetate.
5. Synthesis of 2,4,6-tribromoaniline.
6. Cannizarro reaction: benzaldehyde to benzyl alcohol and benzoic acid.
7. Dehydration of cyclohexanol to cyclohexene.
8. Claisen-Schmidt reaction: benzaldehyde and acetone to dibenzalacetone.
9. Sandmeyer reaction: 4-chlorotoluene from4-toluidine.
10. Pechmann reaction: resorcinol and ethylacetoacetate to 7-hydroxy-4-methylcoumarin
11. Synthesis of 2,4-dichlorophenoxyacetic acid.
12. Synthesis of resacetophenone .

Ch-107: Organic Practical-II (Qualitative Aanlysis)

Qualitative analysis: Systematic analysis and identification of bifunctional organic compounds.

Ch-108 :Organic Practical – III (Preparation two/ three stages)

1. 4-Bromoaniline from acetanilide.
2. 3-Nitrobenzoic acid from benzoic acid/methyl benzoate.
3. 2,4-Dinitrophenylhydrazine from chlorobenzene.
4. N-Methylanthranilic acid from phthalic acid.
5. Benzanilide from benzophenone.
6. Benzilic acid from benzoin.
7. Synthesis of acridone.
8. Synthesis of hydantoin.
9. Anthracene to anthrone
10. Succinic acid to N-bromosuccinimide.
11. Maleic acid to dimethylacetylenedicarboxylate.

Ch-109 : Organic Practical-IV (Quantitative Analysis)

Quantitative analysis

1. Titrimetric estimation of mono-, dicarboxylic-, amino- and aryloxyacetic acids.

2. Saponification value of oil.
3. Estimation of glucose by Fehling's method/Bertrand's method.
4. Estimation of keto-group.
5. Estimation of phenols.
6. Iodine value of oil (Chloramine-T method)
7. Acid and ester, acid and amide in the mixture of two.

SUGGESTED BOOKS

1. Vogel's Text Book of Practical Organic Chemistry – 5th edition, B. S. Furniss, A. J. Hannaford, P. W. G. Smith and A. R. Tatchell - Pearson, (2003).
2. Laboratory manual of Organic Chemistry- B. B. Dey, M. V. Sitaraman and T.R. Govindachari, Allied Publishers, New Delhi, (1996).
3. Practical Organic Chemistry, IV edition, – F. G. Mann and B. C. Saunders, - Pearson, 2009).
4. Text Book of Practical Organic Chemistry including qualitative analysis – IV Edition, A. I. Vogel and A. R. Tatchell, Longman, London, (1996).
5. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996).
6. A Handbook of Organic Analysis – Qualitative and Quantitative – IV Edition, H. T. Clarke, Hodder and Staughton, New Delhi (2017).
7. Comprehensive practical organic chemistry: Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
8. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India),2000.
9. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A.Kr. Nad, New central book agency, Calcutta, 2000.
10. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.
11. Practical organic chemistry (Quantitative analysis), B. B. Dey, M. V. Sitaraman and T. R. Govindachari, Allied Publishers, New Delhi,1992.
12. Advanced Practical Organic Chemistry, III Edition, J. Leonard, B. Lygo and G. Procter, CRC Press, Routledge, (2013).
13. Qualitative Organic Analysis – Spectrochemical Techniques W. Kemp, II edition, Mc-Graw Hill, London, (1986).

PHYSICAL CHEMISTRY PRACTICALS
(4 days a week, 4 hours a day)

C-106 : Physical Chemistry Practical -I

1. Study of Acid catalysed hydrolysis of methyl acetate at lab temperature and reporting the calculated and graphical rate constants
2. Determination of Velocity constant for the saponification of Ethyl acetate at lab temperature and comparing it with graphical value.
3. Verification of Beer's Law: Colorimetric estimation of Cu^{2+} ions and reporting the Molar extinction coefficient.
4. Determination of heat of solution of a sparingly soluble salt.
5. Colorimetric estimation of Fe^{2+} ions in a given solution by titrating FAS versus $KMnO_4$ solution.
6. Study of kinetics of the reaction between KI ad $K_2S_2O_8$solution.
7. Construction of phase diagram of two component systems and determination of Ec , ET and the

Composition of given unknown.

8. Determination of partial molar volume of solute – water system by apparent molar volume method.
9. Analysis of a binary mixture by viscosity measurement method.
10. Verification of Freundlich and Langmuir isotherm for adsorption of oxalic/acetic acid on activated charcoal.

C-107: Physical Practical -II

Conductometric Experiments

1. Precipitation titration of lithium sulphate versus $BaCl_2$ and reporting the concentration of Li_2SO_4.
2. Determination of concentration of a weak acid by titrating against a weak base.
3. Determination of a dissociation constant of weak acid (CH3COOH).
4. Determination of Equivalent conductance of a given strong electrolyte.
5. Determination of the concentration of a strong acid and a salt in a given a mixture of by titrating against a strong base.

Potentiometric Experiments

6. Determination of single electrode potential of Cu^{2+}/Cu and estimate the given unknown concentration.
7. Determination of single electrode potential of Zn^{2+}/Zn and estimate the given unknown concentration.
8. Titration of $AgNO_3$ versus KCl and estimation of the concentration of $AgNO_3$.
9. Determination of pKa and Ka values of the weak acid by titrating against a strong base using quinhydrone electrode.
10. Determination and comparison of pH values of buffer solutions by using quinhydrone electrode and glass electrode.

C-108 : Physical Chemistry Practical -III

1. Study of acid hydrolysis of methyl acetate for two different concentrations of HCl and reporting the relative strength.
2. Study the hydrolysis of methyl acetate in the presence of HCl at two different temperatures and reporting the energy of activation.
3. Determination of dissociation constant of a given indicator by colorimetric method.
4. Study of kinetics of autocatalytic reaction between $KMnO_4$ versus oxalic acid.
5. Determination of degree of hydrolysis of aniline hydrochloride at room temperature and calculation of dissociation constant of the base by pH metry.
6. Study of variation of viscosity of a liquid with temperature and determination of the constants A and B.
7. Analysis of a binary mixture of two miscible liquids by surface tension method
8. Construction of phase diagram of Urea - KCl -H_2O system.
9. Determination of heat of neutralization of two acids and their relative strength.
10. Evaluation of Arrhenius parameter for the reaction between $K_2S_2O_8$ versus KI (first order)

C-109 : Physical Chemistry Practical -IV

Conductometry

1.Determination of concentration of mixture of strong acid and weak acid versus strong base.
2. Determination of concentration of Weak acid with salt versus strong base.
3. Determination of strength of a strong acid, weak acid and a salt versus strong base
pH metry
5 Determination of the acidic and basic dissociation constant and isoelectric point of an amino acid by pH metry.
6. Determination of pKa valueor Dissociation constant of phosphoric acid.
7. Determination of pH of acetic acid with sodium acetate buffer.
Potentiometry
8. Determination of concentration and amount of $K_2Cr_2O_7$ by titrating against FAS and calculation of redox potential.
9. Determination of concentration of mixture of acids by titrating against NaOH solution.
10.Determination of concentration of $KMnO_4$by titrating against FAS and calculation of redox potential.

SUGGETED BOOKS

1. Advanced Practical Physical Chemistry by J. B. Yadav, GoelPublications, Meerut (2012).
2. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers, New Delhi (1987).
3. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
4. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968).
5. Experimental Physical Chemistry by Wilson, Newcombe& others, Pergamon Press, New York (1962).
6. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983).
7. Experimental Physical Chemistry by V. D. Atavale and ParulMathur, New Age International, New York (2001).
8. Practical's in physical chemistry A. Modern Approach by P.S Sindhu, Mac. Millan Publishers, Delhi (2006).